LIA09838

[illegible]

[illegible] production [illegible] but our interests are in the [illegible] gas mixture coming from the [illegible].

Processing of the hot corrosive gas mixture is carried out in equipment fabricated from sheet lead with [illegible] steel supports. The [illegible] settlers, as well as the [illegible] (SO_2), scrubber and [illegible], contain a corrosive solution (complete analysis given below) that has had no appreciable action on lead in over 9 years service. However, this solution [illegible] stainless alloys of [illegible] and [illegible] types at rates of 0.0[illegible] to [illegible] in. per year and sometimes faster. During the past [illegible] months, the [illegible] has contained, in addition, 1.5 grams per liter of fluorine and there has been no apparent effect on the lead lining. Other lead lined equipment, [illegible], etc. have given over 16 years excellent service handling roaster gases at varying temperatures.

A. INTRODUCTORY HISTORY

The Josephtown smelter for the production of electrothermic zinc is located on the Ohio River about 25 miles northwest of Pittsburgh, Pa. In addition to concentrates from the company mines in St. Lawrence County, New York, foreign ores are now handled from such places as Quebec and Argentina.

The operations of the smelter consist of:

(1) Roasting the sulfide concentrates;
(2) Converting the sulfur dioxide into sulfuric acid;
(3) Preparation of a strong structure sinter from the calcine;
(4) Crushing and sizing of [illegible]
(5) Reduction of [illegible] by electrothermic means;
(6) Condensation of the [illegible] zinc vapor to [illegible] metal or burning of the [illegible] zinc [illegible]
(7) The collection and [illegible] of the zinc oxide [illegible] recovered by the roaster and [illegible] are treated in the leach plant for separation of lead sulfate, cadmium metal and zinc sulfate.

At present, construction of new equipment will bring about a 70% increase in plant capacity. This has entailed extensive use of sheet lead in the construction of items such as coke filters, Hot Cottrells, ducts for handling corrosive gases and a new settler tank 100 ft. in diameter which will be possibly the largest lead covered tank ever built.

B. PROCESS DESCRIPTION

The Anaconda zinc smelter can be divided into the following plants: roaster and purification plant, acid plant, leach plant, cinter plant, fumace plant, and bag house. As we are interested in lead construction we will discuss only the SO2 gas purification plant as that is where by far the most lead is used. Other items of lead equipment are used throughout the rest of the smelter and will be discussed briefly.

High grade zinc sulfide ore (57% zinc, 32% sulfur with small percentages of lead, iron and cadmium) is roasted for about 12 hours at 720 to 950° C. to convert it to crude zinc oxide (calcine). The combustion products are taken through a waste heat boiler from which steam is provided for plant uses. The rabble arms in the hearth furnaces stir up a very fine ore dust which is removed from the gas by a Cottrell (electrical precipitator), known in the plant as the hot Cottrell or dust Cottrell.

The hot gas (290° C.-554° F.) enters the scrubber cooler (see Drawings Nos. 1 and 3) where in a brick lined chamber it passes countercurrent to coolant liquor and then passes upward through 13 ft. of spiral ring packing. Downward flow of circulating zinc sulfate solution (analysis below) cools the hot gas before it enters the mist Cottrells. Here the sulfur trioxide is removed in the form of a sulfuric acid mist, and this drip acid is run to a settler tank where it joins the returning coolant from the scrubber-cooler. After passing through the two exposed tube mist Cottrells the SO_2 gas passes through a preliminary coke filter and then a final coke filter. Drip acid from both coke filters is sent to the settler tank as shown on Drawing No. 1. The gas then passes on to the acid plant where concentrated sulfuric acid is made by the contact process.

C. EQUIPMENT DESCRIPTION

The first place where the hot SO_2 gas encounters lead as a lining is in the scrub tower. Here the gas enters a humidifier chamber 6 ft. 8 in. high constructed of 12-lb. lead and three courses of acid resistant brick on the bottom and 12-lb. lead and a 12-in. course of brick on the sides. The gas enters at 290° C. through a cast iron entry sleeve, passing through the downward circulating coolant.

The upper portion of the chamber is constructed of 10-lb. lead and one course of brick and is packed to a height of 13 ft. 5 in. with 6-in. and 3-in. single spiral rings through which the cooling liquor flows at a rate of 15-lb. per min. for each square foot of cross section. The top of the scrub tower is fabricated of 10-lb. sheet lead supported by 2-in. steel pipe on 1 ft. centers over which are wrapped 4-in. supporting bands of lead. Zinc sulfate solution containing from 40-140 g/l of sulfuric acid is used as a cooling solution and circulated as shown on Drawing No. 1 through lead pipe and lead lined equipment. In pumping the gas through to the mist Cottrell 10 in. of vacuum are applied.

LIA09840

Included in the Scrubbing Tower [illegible] are circulating coolers and settlers. Clear solution [illegible] lead pipes [illegible] through [illegible] 1-1/2 in. [illegible] cooling water at the rate of [illegible]. Cooling water ranges from [illegible]° F. and [illegible] [illegible] there are [illegible] 2 to 3 [illegible]. [illegible] after passing [illegible] the settler. [illegible] internal diameter of the lead tubing [illegible] sq. ft. of [illegible] [illegible]

Two settlers of [illegible] are used and are constructed with a concrete [illegible] lead. A [illegible] vertical side portion of lead [illegible] by I beams and [illegible] with [illegible] lead tape. The [illegible] settler is shown in Drawing No. [illegible] required for this [illegible] large diameter [illegible] will flow out through the overflow [illegible] of concrete and lead construction as is also shown in Drawing No. 2. Extra courses of brick can be used as shown in Drawing No. 2 to increase the amount of liquid stored in the settler. Concentric lead pipes will remove sludge from the lead lined sludge trap at the bottom of the settler. The 10-lb. lead on the sloping sides will be supported by a series of radial lead covered steel straps converging toward the center. In place of one long strap from top to bottom, short straps with a 6-in. gap between each strap length of 3 ft. will be used. Along any circumference, 24 to 30-in. will be the maximum distance between these straps.

After leaving the scrub tower the gas next passes through two exposed tube mist Cottrells in series which removes the sulfur trioxide in the gas as a sulfuric acid mist. In the Cottrell steel lead covered star-shaped wires are suspended in the center of 10-in. diameter lead tubes which are positively charged and collect the mist which has become negatively charged from the star wires. A potential of 60,000 to 70,000 volts D.C. is maintained between wire and tube. In a typical Cottrell there are 96 lead tubes 10-in. in diameter, 12 ft. long and two tubes 13-in. in diameter which contain the two lead covered steel supporting bars that support the bottom frame work which keeps the wires centered in the tubes. The tubes are exposed to the atmosphere along approximately 2/3 of their length while temperatures inside vary from 25 to 40° C. The sheet lead forming the large upper and lower chambers is supported by means of horizontal steel straps 4-in. wide on 12-in. centers. There are 32 tons of 10-lb. sheet lead in the Cottrell which is 28 ft. 8 in. in height.

The gas next passes through two coke filters which are rectangular chambers constructed of 10-lb. lead. The first of these has 6-in. of 2 to 5 mesh coke and the second has 4 ft. of coke varying in size from 1-1/2 in. down to 20 or 40 mesh. Drip acid from these units is taken through lead pipe to the settler while the SO_2 gas is passed through drying towers, which is the first step in the contact process for making concentrated sulfuric acid.

New centrifugal type blowers, made by Roots-Connersville and the Elliot Company are being installed at present for SO_2 gas pumping. Until recently positive displacement blowers have been used.

D. PERFORMANCE OF LEAD

Throughout the purification plant lead has given very satisfactory service in the 17 years of operation. The gas entering the scrub tower, constructed in 1937, at 290° C. (554° F.) is much too hot for contact with lead and enters through a cast iron sleeve. However, beyond the sleeve 12-lb. lead covered by 3 courses of acid resistant brick has done the job of handling the hot corrosive SO_2 and SO_3

vapors as they pass through the coolant liquor. The only major trouble experienced in the scrub tower was spalling of the brick which exposed the lead, causing it to salt out. An improved design has completely eliminated this source of trouble.

In the mist Cottrell high voltages throw dilute sulfuric acid out of the moving gas stream on to lead pipes at temperatures ranging from [illegible] C. The same length of service by sheet lead has been given in both mist Cottrells and spray filters (first units constructed in 1930) with negligible corrosion.

Corrosion has likewise been nil in the [illegible] and 50-ft. sections which handle the coolant used in the SO_2 scrubber-cooler. Almost 10 years' [illegible] service has been given here by the lead linings and pipe installations as at present handling the following corrosive solution at specific gravity of 1.28:

TYPICAL ANALYSIS

Zinc	37.5 grams per liter
Cadmium	2.47 " " "
Iron (ferrous)	4.1 " " "
Sulfuric Acid	56.5 " " "
Chlorine	1.7 " " "

During the past 18 months the circulant has contained in addition to the above, approximately 1.5 g./l. of fluorine with no apparent effect on the lead linings. The above solution has been tested with various bronzes and durimet and worthite types of stainless alloys which have been found unsatisfactory as they have corroded at rates of 0.004 to 0.1 in. per year and sometimes faster.

II. PERFORMANCE OF OTHER UNITS OF LEAD EQUIPMENT

1. Evaporators. Two tubular evaporators are used in the leach plant to concentrate the zinc sulfate liquor. These are of 1-1/2-in. cast lead and have an 80-in. steam chest through which run a large number of 1-1/4-in. outside diameter tubes 50-in. long. Vacuum applied is 20-25-in. of mercury. Generally only one of these evaporators is in use at a time (with the others as a stand by). Tubes in one evaporator are of carbon costing $4.00 each while the other contains $17.00 lead covered copper tubes. The cheaper carbon tubes break frequently but the lead-copper tubes fail because of pitting with large holes forming and no particular time rate of failure involved. Except for the excessive breakage feature the carbon tubes give excellent service. It is a toss up which is the better tube from the standpoint of length of service and cost of tube. For future design they may go to 7% antimonial lead tubes and cut short the length of tubing by using two shorter steam chests in place of the 80-in. chests now in use.

2. Crystallizer. In the leach plant following evaporation the zinc sulfate liquor is crystallized in a rubber lined vacuum crystalliser. A special 3/8-in. hard rubber lining is bonded to the steel shell wherein the zinc sulfate crystals are agitated. This hard rubber lining resists abrasion by the crystals. Except for extensive failure around the manhole it has given good service with only minor repairs required in almost 10 years.

3. Vacuum Filter. Crystals are removed from the [illegible] by means [illegible] rotary vacuum filter. The filter drum is [illegible]-ft. in diameter by 2-ft long. In its [illegible] years of operation this unit has required no repairs other than an occasional replacement of the filter cloth ([illegible] rubber [illegible]).

4. Valves in Large Lead Conduits. [illegible] large lead, [illegible] [illegible] plant to convey the [illegible] to the [illegible] a lead covered sheet [illegible] lifted from the conduit to [illegible] the direction of gas flow. This caused a [illegible] which has been eliminated by the use of butterfly valves which when open allow free gas passage around the lead covered circular steel plate. The gas flow is gradually decreased and finally stopped by turning the circular lead covered steel plate 90° to the path of the gas flow.

5. Reaction Tanks – Filter Press. Several lead lined reaction tanks in the leach plant have given excellent service, handling among other materials a dilute sulfuric acid. The company engineers are particularly careful in constructing these lead lined tanks to see that the sheet lead is firmly pressed against a smooth steel surface. It is imperative that there be no sharp edges behind the lead tank lining. All weld seams, slag splatters, corners etc. are chipped, then ground smooth before the lead sheet is applied. Another plant practice here that is not generally observed elsewhere is the use of wooden forms cut on a proper radius to press the sheet lead firmly against the tank.

A lead filter press has also given good service filtering out lead sulfate suspended in weak acid. This lead compound is shipped to the company's lead works in Missouri for refining.

6. Dorr Thickner. Leach plant equipment includes a 60-ft. diameter Dorr Thickner. The tank is of concrete lined with 6-lb. lead which in turn is covered with acid-proof brick. The rake mechanism is of steel, lead covered. The rakes themselves are of hard lead containing a dispersion of abrasion resistant refractory grains. This rake metal is known to the trade as "plumbalum."

CONCLUSIONS

When the temperature of the corrosive SO_2 and SO_3 vapors is reduced by the scrub tower to a range suitable for contact with lead, the gases, wet or dry, have been handled in lead ducts and equipment fabricated from sheet lead for almost 17 years with no appreciable corrosion. This also applies to the corrosive circulant of analysis given above in d. A newly constructed scrub tower, built in 1937, with adequate brick lining over the lead to handle the high temperature involved is expected to last indefinitely.

1. Where the hot 290° C. (554° F.) gases enter, a cast iron elbow is used.

2. Where the hot gases pass countercurrent to the coolant liquors at about 350° F., three courses of brick are used over the 12-lb. sheet lead bottom and a 15-in. course of brick is used over the 10-lb. lead sides.

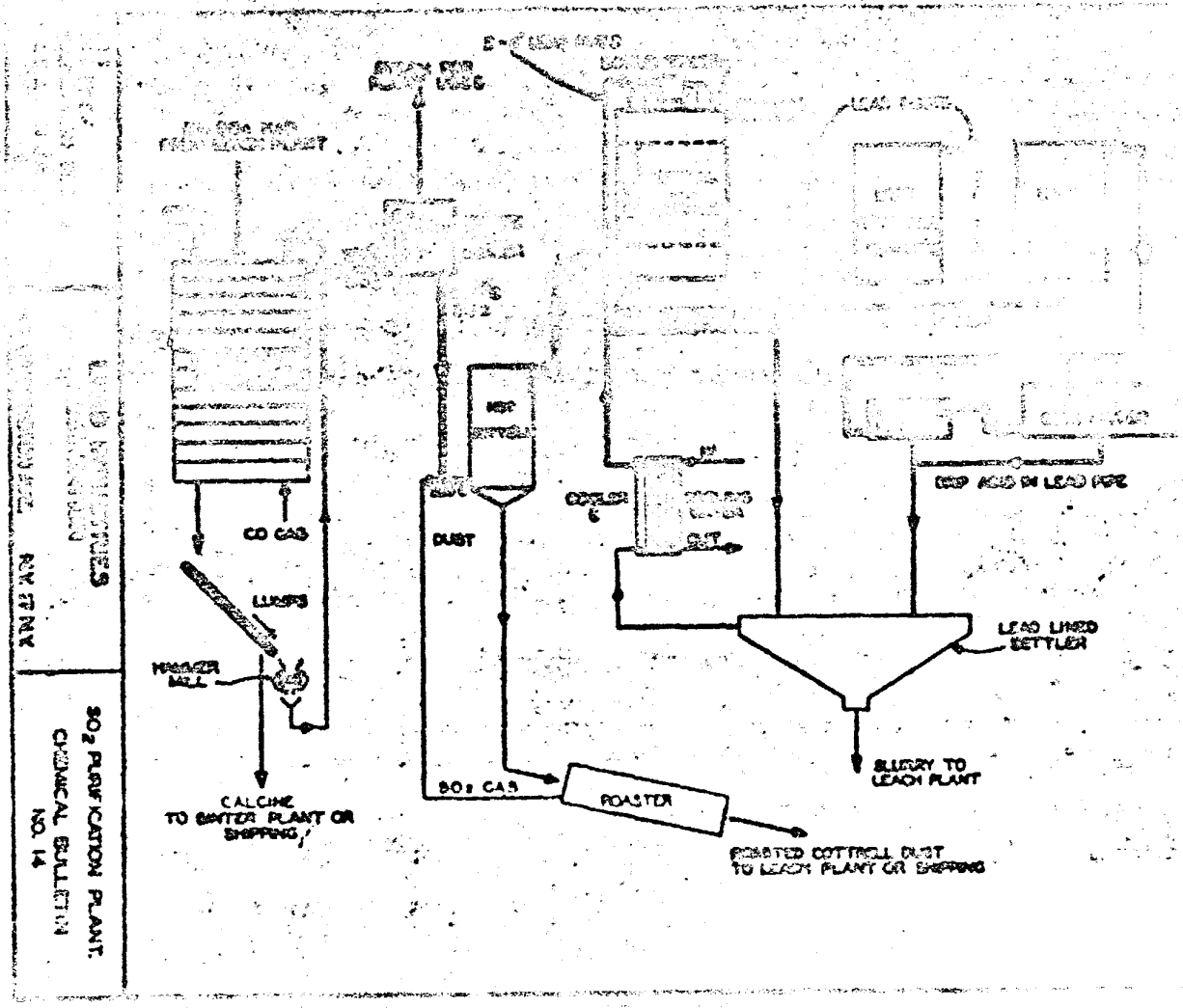
3. In the packed chamber above, one soldier laid course of brick is used over 10-lb. lead.

In the 100-ft. settler tank the 10-lb. lead lining on the 30° sloping sides is well strapped. Maximum circumferential distance between the radial straps is 24-30 in. and each strap is broken for a 6-in. gap at intervals of 3 ft.

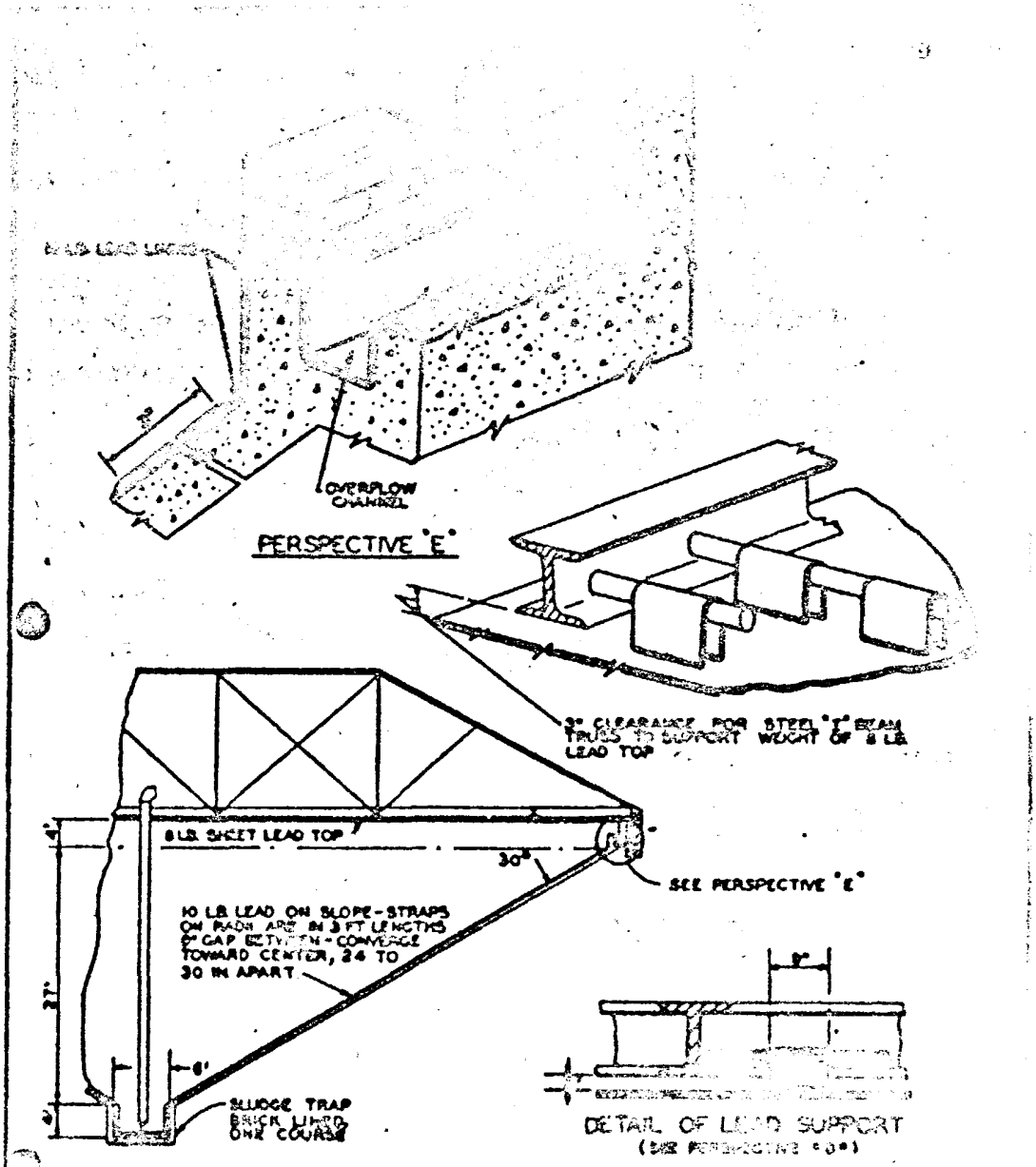
<u>OTHER LEAD EQUIPMENT</u>

Dilute acid tanks, lead lined, have held up well over the 17 year period of plant operation as have other lead items such as filter presses. Cast lead evaporators are excellent in service but the 90-in. tubes of 1-1/4-in. outside diameter are a source of trouble. Lead-copper tubes fail from extensive pitting and are more costly than the carbon tubes which however break easily. A rubber lined crystallizer has given excellent service combatting the abrasion from agitated zinc sulfate crystals.

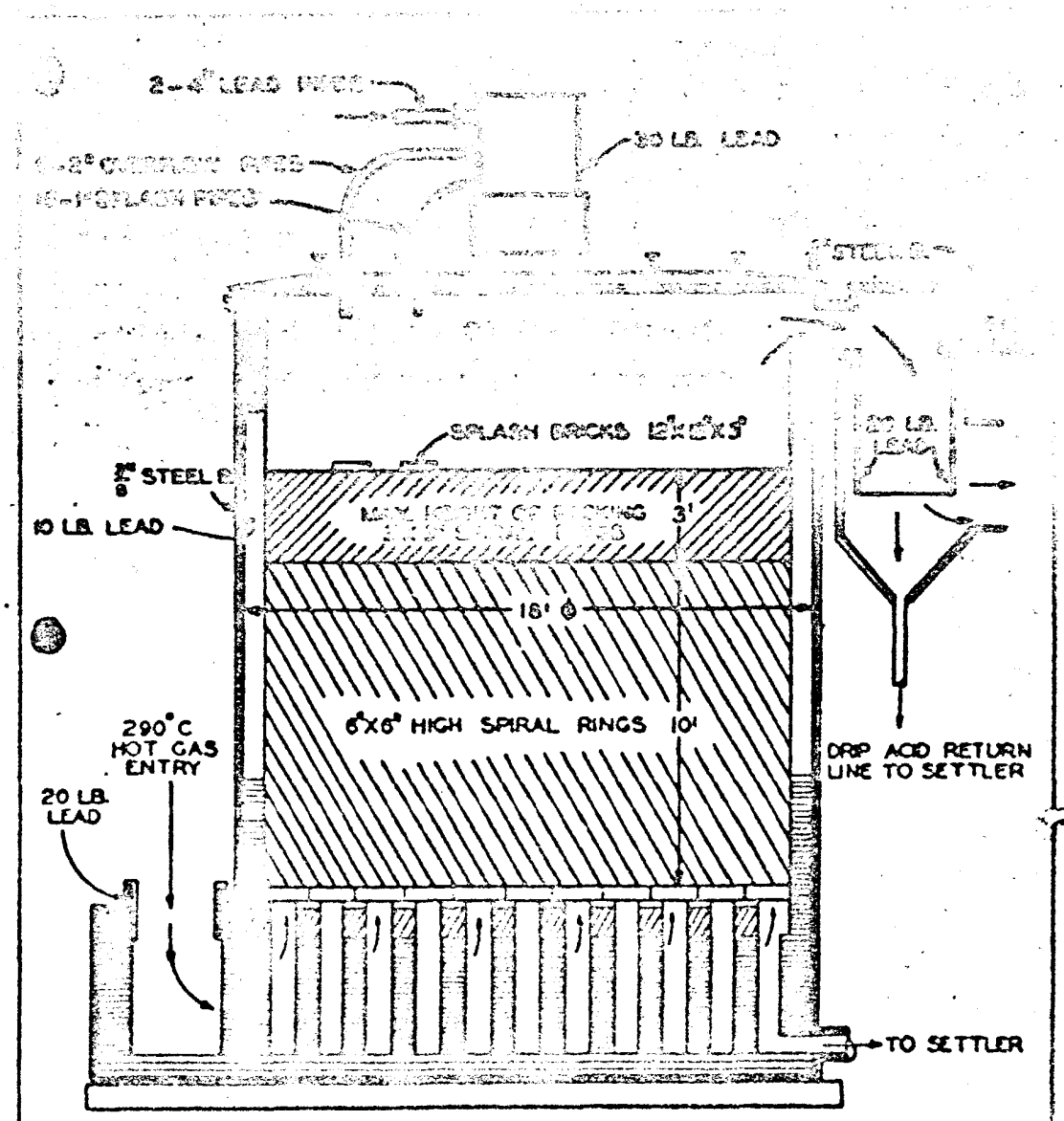
Excellent service from lead lined equipment is often the result of proper care in installation. Here, wooden forms curved to fit the tanks are used to press the sheet lead firmly to the carefully smoothed tank surface. When a lining of brick is installed, ample cement is daubed over the brick surface that will make the brick to lead contact.



SO_2 PURIFICATION PLANT.
CHEMICAL BULLETIN
NO. 14



LAG NO. 2 100 FOOT SETTLER BY: H.M. CHURCH JR. FEB 28 1947	LEAD INDUSTRIES ASSOCIATION 420 LEXINGTON AVE NY 17 NY	SO_2 PURIFICATION PLANT CHEMICAL BULLETIN NO 14



DRG. NO. 3 SCRUB TOWER BY H.M. CHURCH JR. FEB. 21, 1947	LEAD INDUSTRIES ASSOCIATION 420 LEXINGTON AVE. NY 17, NY	SO_2 PURIFICATION PLANT. CHEMICAL BULLETIN NO. 14