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EARLY HISTORY

o f

THE SOLVAY PROCESS COMPANY

B y

EDWARD N. TRUMP.

(In Chapters)

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Chapter v. Visit of ERNEST SOLVAY, and  
Program of Improvements suggested.

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## CHAPTER V.

### VISIT of Mr. ERNEST SOLVAY.

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The operation of N° 2 Element, starting in February 1886, was a great improvement on N° 1. The new pumps were a great blessing, and the new D. S. also worked so well that we began at once to make preparation to remodel the D.S. to N° 1, and replace the gang of pumps there.

The R.H. on top of the D.O. enabled us to run two D.Ss at a time if we wanted to, or to change without shutting down.

The D.S., shown in Plan K-1157,<sup>p 42 Vol III</sup> was our own design, changing the old model entirely. The information obtained from visits to Solvay & Company's Works, and to Brunner, Mond & Co., and from plans of improvements they had made, coupled with our own experience, led us to design according to the following principles:

- 1st. The "fauxfonds" (plates between compartments) were made to conform nearly to the shape of the sand which was deposited in the compartments of the D.S. in N° 1 Element.
- 2nd. The center holes were enlarged to one foot six inches, and the entrance made on easy curves to reduce friction.
- 3rd. The overflows were made wider and over the edge of the plate of the shell, to reduce the chance of deposit of sand on them; also the bubbling height (barbottage) was easily reduced from  $7\frac{1}{2}$  in. to 4 in. by cutting off plates.
- 4th. The manholes were made round, 15 in. diameter, and with bolts held in lugs with pins so they would swing out of slots in edge of cover by loosening the bolts without taking off the nuts and washers, with less likelihood of their being lost. The joints were made wide and grooved so that pasteboard gaskets could be used.
- 5th. The overflows were split the whole length, and the

joints made the same as the manhole covers. The shape allowed easy cleaning, and a nozzle was provided on the bottom to drain the compartment, and the entrance into compartment made smooth and of maximum size.

6th. The passette was designed to give areas under and over, enough larger than the central nozzle to allow for scale building, and with teeth that were strong and of a shape easily cleaned.

7th. The shape of the parts allowed the maximum room for the workmen, who had to enter, for chipping off the 3 inches of scale which formed in two months, and a manhole on each side gave good ventilation needed to stand the ammonia.

8th. The top compartment was made 6 ft. high, and a plate baffle suspended under the R.H. bottom plate to prevent projection of the lime into the compartment above.

9th. The old style of base, made with ribs, had broken from shrinkage cracks, and it was designed pan-shape, giving greater strength and greater height for the small lowest passettes.

These principles have been followed in all the D.S. which have since been designed, and the only changes have been to enlarge the center hole and the passette accordingly, and to enlarge the overflows. The European Works have also adopted the shapes and arrangement.

The shower R.H. was copied from a design of Brunner, Mond & Co., increasing the diameter, but was gradually modified by adding compartments with passettes until all of the showers were eliminated. These compartments were tried, 3 in number, on top of the showers, and then underneath, and by 1893 all of the R.H. was a barbotage apparatus.

Plan D-1296,  
1/17/1887

Shows the arrangement of the remodeled Apparatus Room of Element No 1, when it was completely changed with two new D.S. and R.H., 4 new Compressors and Apparatus Pumps.

PRODUCTION  
1886

The production of Soda Ash for the two Elements gradually increased from 57.6 tons per day in January, to 93.9 tons for December. The summer months were about 60 tons, and the average for the year 86.4 tons, equal to 64.2 tons for one Element.

By April of 1887 we were producing 100 tons per day, but the rebuilding of No 1 Element cut it down to 70 tons per Element for the balance of 1887. The average for that year was 110 tons.

The lime kilns furnished gas of only 32% or 33%  $\text{CO}_2$  until the end of May 1887, when it increased to an average of 37 to 38%, due to the increase in the height of the lime kilns.

The increased number of S.H. and better regulation of the suction, giving a gas of 70 to 80% to mix with the kiln gas, gave Compressor gas of 40 to 42%, with better work in the C.Ls and yield of Bicarbonate, so that the yield increased from 42% in 1885 to 46% at the end of 1886.

Brine Saturation:

Plan R-1067  
1/18/1885.

The brine saturation, which had saved so much labor in the salt house, was designed February 18th, 1885, under stress of need, because we could not get saturated brine by the old method.

The elevator shown received the salt conveyed by wheelbarrows and dumped into it, and delivered it into the hopper in cone saturator, where it was dissolved by the incoming brine pumped direct from the wells. The saturated brine overflowed into the wooden tank where any slight excess of salt settled out and was shoveled back into the cone.

A second saturator was put in later to make a spare. The labor of shoveling and wheeling salt from the boats or cars was a considerable item of expense, especially as much of the salt had to be shoveled up into piles in the salt storehouse over the tanks, to store enough to tide over irregularities of arrival of cars and boats.



Plan C-1222 In May 1886 we designed a salt unloading and handling plant, shown in Plan C-1222, which saved a great deal of this labor, as the salt from either boats or cars went direct to the two saturators, or the surplus to conveyors overhead that delivered it onto piles for storage.

The labor per ton of Soda for 1884 was 40 hours, and for 1885 - 31.5 hours, but was reduced by improvements in 1886 to 25.2, where it stayed for the next two years.

OILERS: The Boilers were 208 H.P. B. & W. Boilers, with perforated grates and with steam blowers under them.

We burned small anthracite culm coal, such as was commonly used in the salt blocks, and finally began to receive No 1 Buckwheat coal, which became our standard fuel.

Visit of E. Solvay:

In September, 1886, we received a memorable visit from Mr. Ernest Solvay, the first time he had been over. We had many interesting discussions with him, and his conclusions were summed up at a meeting we held on September 9th, 1886, when Mr. Ernest Solvay wrote out a memorandum, which Mr. Hazard translated, and which is so remarkable for its breadth of vision, and grasp of the improvement which should be made, that I quote it entire.

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Programme of Improvements to be realized, as set forth at a meeting of the Directors on October 26th, 1886.

By Mr. Ernest Solvay.

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LIME KILNS: "At the last analysis we must come to burning the limestone in large blocks from the quarries, or in small pieces broken mechanically, with utilization of the wastage. We think that the first system will be realized with difficulty, because the coke will run in the interstices of the stone, or will present too little surface for the combustion because the time necessary will demand too great an area of wall, hence more heat lost, and a decreased strength of gas, and because the discharge will be more difficult.

The second system will without doubt be found preferable, and will lead to a cupola entirely mechanical, open at the top and at the bottom, and with a forced draft of air; a system which could be patented.

#### Methodical and Continuous Secheur:

It is necessary to be able to decompose Bi-carbonate under pressure to obtain pure carbonic acid. It is necessary to do it methodically to economize heat. It is necessary to do it continuously, because all the operations of our fabrication ought shortly to become entirely continuous, which will save labor etc.

There is in view a horizontal arrangement and a vertical arrangement. If the first system is adopted it must be constructed of ordinary wrought or cast iron tubes of small diameter, and very long. It is necessary to do away with packings; it is necessary to be able to easily replace the wornout tubes. The vertical arrangement will, without doubt, be preferable, because it will save the preliminary mixing of the soda with bi-carbonate, because the mechanism is internal and the shell is fixed, because it may be constructed of cast iron; because it will occupy much less room.

#### Cooling of the Dried Soda:

This cooling should be entirely mechanical and continuous, the soda going directly from the drying to the packing.

#### Preliminary Carbonatation:

With the pure, or nearly pure carbonic acid, the ammonia brine may be entirely mono-carbonated by interposing it between the drying and a vacuum pump. This operation will thus be performed without the employment of motive power, and at the same time the problems of cooling the columns, and of gaining an important increase of the production of soda are solved.

#### ECONOMY of MOTIVE POWER:

##### Preliminary Carbonatation Distillers, &c.:

While we are introducing more mechanical contrivances into our works it is necessary throughout to seek economies of the motive power necessarily employed. The preliminary carbonatation will help us to gain considerable in this direction. The decrease of the volumes to be distilled, and throughout--where that is possible--will help us to make another saving. I am sure we shall be able to save 50% of the actual motive power employed. As all the discharges from the distillation are actually made available nothing will be gained if this is not improved.

DISTILLATION: It is necessary to be able to distill with one-half the quantity of steam which is actually consumed, as indeed theory demonstrated that this can be done. The greater part of the heat is employed in heating the liquid; we must seek to re-employ this heat, for instance - by performing the distillation of the carbonate of ammonia somewhat colder, and then by heating this liquor by that which goes out from the lime distillation. This distillation of carbonate of ammonia could perhaps also be performed by the gases from the lime kilns before or after the compressors.

The milk of lime, which contains useless water, must be done away with, and quicklime must be directly introduced into the distillation. With perfected lime kilns the little pieces will always be thoroughly burnt. This will easily be ground if required, and it will be introduced into the distiller by the aid of the arrangement which has been in operation at Couillet. This will be no more difficult than to make and introduce the milk of lime, and a good liquid will be obtained from which to recover chlorides of calcium.

We should reach the point of consuming only one-half a ton of coal per ton of soda. This is the aim for the future, to be accomplished by the aid of these several improvements.

#### Yield of Salt in Soda:

We must seek what are the conditions to be fulfilled to obtain the greatest possible yield, and this will certainly be by using a higher titre in ammonia, and then it will be necessary to make corresponding increase in the works where required in order to reach this point. From this also we shall have less liquor to be distilled.

#### Decantation, Washing & Filtering of Bicarbonate:

The Bicarbonate may be decanted in a continuous manner from the column liquor. It can, without doubt, be washed after decantation in a column similar to that at Copley, but working at closer intervals if it is necessary. Afterwards the Bicarbonate may be filtered upon a continuous filter, for instance, a drum. Thus the losses of ammonia on filtration will be avoided, and this operation will be more rapidly performed, and without labor."

September 9th, 1886.

(Signed E.S.)

"P.S.: Send the water charged with carbonic acid gas from the S.P.s to the L.F.R., making this apparatus methodical by reason of this change.

The improvements to be made can be recapitulated by economy of raw materials. We can then make out a table by looking successively at these. We shall then have the following classification:

#### C O A L.

##### 1. Boilers.

(a) Motive Power; Preliminary Carbonatation; decrease in the barbotage, and of the volumes to be distilled. D.S. and R.H. of the model of the appropriate column.

(b) Distillation: Quick lime instead of Milk of Lime.  
Recovery of heat from the liquors.  
Decrease of the volumes distilled;  
Higher titres; methodical washing of the Bicarbonate.

##### 2. Secheurs.

(a) Horizontal revolving Secheurs.  
(b) Vertical "  
(c) Cooling of the dried Soda.

#### LIMESTONE and COKE.

##### Lime Kilns.

Kilns of rational dimensions.  
" rendered entirely mechanical.  
Mechanical breaking, with utilization of the spawls.  
Forced draft.  
Suppression of the breaking.

Distillation: Methodical use of the lime and its complete exhaustion.

CARBONIC ACID.

ilns: Gas from the kilns at 40%.  
 echeurs: " " " secheurs at 100%  
 .Ps: Recovery of the carbonic acid gas dissolved by the use of  
 water in the L. F. R.

S A L T.

D. O. Yield of the salt in soda by higher titres, etc.  
 D. S. Quicklime and economy of steam. Decrease of the  
 volumes for the final recovery of salt and of  
 chloride of calcium.

AMMONIA.

Distillation. Reduction of volumes to be distilled.  
 Filters. Decantation, washing and mechanical filtration of  
 the Bicarbonate.  
 S.H. Improvements in regard to strength and tightness.  
 Washers. Sundry improvements.

L A B O R.

The operations rendered more and more mechanical, meth-  
 odical and continuous."

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We have not yet finished with this program. It is so  
 broad that it covers, by suggestion, nearly all of the im-  
 provements which have been made, either here or abroad.

This does not detract from the credit due our staff for  
 carrying out the detail of the improvements, as it is much  
 easier to tell what should be done than to devise the detail  
 of doing it.

As we look over the items we see the Lime Kilns carried  
 out in the S.L.K.; the Methodical & Continuous Secheur in  
 the S.H.T.; the "Cooling of dried Soda" in the Rotary  
 Cooler; the "Preliminary Carbonatation" in Washing C. L.  
 System; the "Decantation & Washing of Soda" with "Continuous  
 Filtering by means of a drum" in the Rotary Filter.

We tried the vacuum system of carbonatation, but the  
 development of the washing system of the C.Ls required  
 pressure, so we have not saved the power he suggested.

We have improved the distillation by saving the heat going out with the gas, but only a part of the heat from the D. S. Waste liquor has been saved.

We have not yet used dry lime instead of milk of lime, and have not reached an average of 40%  $\text{CO}_2$  in the kiln gas, or 100% in the S.H.T. gas.

This program was of immense help during the next few years. We worked towards its realization as fast as possible, and were aided by suggestions and plans received from the Solvays in exchange for those we sent them.

Suggestions were made and adopted on both sides, and traces of these designs are still seen in the modern apparatus in all the works.

The D.S. and R.H.; the Rotary Filter, the C. Ls, the S.H.T. and M.L.T., are all examples of this interchange of information, and show the great advantages of co-operation.

The visits which Mr. Cogswell and the writer made to all the European Works, and the discussions with the Engineers, especially Mr. E. Hannon, and Mr. Glendinning, of Brunner, Mond & Co., were a great help to us, and we improved rapidly in technical results

Messieurs Solvay et Cie sent over to us copies of their Quinzaine Reports, giving information and comparison of the work done in each of their Elements.

To show how our work compared, we give on the following page, the results for the last of 1884, 1885 and 1886:

PRODUCTION (Tons per day)

<u>DECEMBER:</u>	<u>Syra-</u> <u>cuse.</u>	<u>Couil-</u> <u>let.</u>	<u>Dombasle.</u>	<u>Whylen.</u>	<u>Bern-</u> <u>burg.</u>	<u>Saar-</u> <u>albe.</u>
1 8 8 4	46	26	182	58	53.7	0
1 8 8 5	57	32.6	206.5	66.5	69	28
1 8 8 6	85	34	292	83.4	77.2	72

CO<sub>2</sub> in KILN GAS: %

1 8 8 4	24.5	28	24.5	28.2	30	
1 8 8 5	34.1	31.5	31.5	31.7	37	28
1 8 8 6	32.6	33.2	32.5	37	33.5	35.7

YIELD of BICARBONATE: %

1 8 8 4	46	42	44	43	41	
1 8 8 5	44	47.5	46	41	45	44
1 8 8 6	43	43	47	44	40	45

AMMONIA LOSS: (Kilos per ton of Soda)

1 8 8 4	45	26	40	27	37	0
1 8 8 5	40	35	25	27	27	27
1 8 8 6	28	29	15	24	27	40

The above table shows that we obtained about the average results of the Works, with equal production.

The production was always limited by the S. H., which was very inefficient.

H.

We had in -

1885.	8 S.H.	for	44 tons Soda	=	5.5 tons <sup>for S.H.</sup> in N°1 Element.
1886.	20 "	"	86 "	"	= 4.1 " " N° 1 & N° 2
1887.	28 "	"	110 "	"	= 4. " " N°1 & 2 & $\frac{1}{2}$ Annex
1888.	36 "	"	142 "	"	= 4. " " N°1 & 2 & Annex
1890.	49 "	"	200 "	"	= 4. " " N°1 & 2 & "

The capacity could not be pushed up much above 4 tons of Soda, and get ash that was well calcined. We therefore had to increase our number of S. H. by building the two Annexes. We also found it necessary to make some Dense Ash, and erected a Mac Tear Furnace in N° 2 Annex.

#### S.H. in Series:

We tried connecting four of them together by means of feed and discharge conveyors, so that the Ash would pass through the four in series. This worked fairly well except the first one, which scaled with the very wet B.C., with only 43 or 44 yield.

Tubular S.H.: At Dombasle about this time they tried to dry Ash in a series of horizontal tubes, one above the other, in a furnace, each provided with a ribbon conveyor, which pushed the B.C. along dropping it into the tube below by connections at the ends.

This was not a success, because of scale and great power required.

We were always hunting for a continuous form of S.H. We made a sketch of an S.H. consisting of a series of pans with curved bottom, like the S.H. pan, with holes in the center, each provided with a cover connecting to the next pan above, with arms and knives on a central shaft. The space between the pan and cover was to be heated by gas from the furnace of the S.H. to economize the heat.

This plan would, probably, have worked well if the mechanical details were all right.

#### Finishing Machine (F.M.)

The English type of Thelen Machine, or Finishing Machine, was never tried at Syracuse, as Solvay & Co. were experimenting with the S.H.T. when B. M & Co. had perfected their machine, and they preferred us to try out those rather than use the F.M., which B. M. & Co. have continued to use and improve to this day, and prefer to the S.H.T. They always

disagreed with Brussels on this point, and we wanted to try some, but were advised to use the S.H.T. instead.

NNEX N° 2: At the end of 1887 we were making 140 tons per day from two Elements, 70 in each set of 5 C.Ls, and had 36 S.H., which dried an average of 4 tons of Soda each, per 24 hours.

The N° 2 Annex was built during 1888, and 8 S.H. added, followed by 4 more, and the Mac Tear densification furnace, with its gas producers, in 1890. This Mac Tear gave a very dense ash, which was thought necessary by the glass makers, because they were used to Tarrent's English ash, and we followed the practice of Brunner, Mond & Co., who were using these furnaces, and who continued to use them in spite of their inefficiency, for many years.

After we began to use the S.H.T. we replaced this furnace by a long Rotary Furnace, with internal firing with producer gas, which were later abandoned when we began to make Dense Ash at Detroit by the water system.

ound B.Ls: Three large B.Ls were put in to handle and pack the ash, with the screens and elevators, but we still continued to handle the hot ash in the cellars by means of shovels and large wheelbarrows.

With this equipment we reached a production of 200 tons of ash per day in 1891, and were compelled to increase our distillation by building N° 3 Apparatus Room.

Plan 1751.  
/18/1891. N° 3 Apparatus Room, Plan 1751, shows the modified equipment that had grown up from the improved design worked out in other changes in N° 1 and N° 2.

iedler Compressors:

We had trouble with the Ingersoll Compressors, and the Weiss Compressors were good, but not as efficient as we wanted. We learned of the Riedler Compressors then being brought out by Frazer & Chalmers. Dr. Riedler visited us



and Johann Stumpf, his Engineer, designed a Compressor to suit our needs, with 36 in. stroke, 30 in. diameter gas cylinder, compound steam cylinders for 10 lbs. back pressure.

We put two of these in N° 3 Apparatus Room, connecting the gas to N° 2 C.L. We began to use sprays of soap solution in cylinders, and soda solution afterwards.

The D.S. and R.H. (2 in number) were of the modified type. We had abandoned the showers, and used full barbotage the whole height of R.H., using single passettes in each compartment. Extra D.Os were used, but the A.Bs were left in N° 1 and N° 2 Element, 4 A.B. being used for all D.S., with R.F.R.H. of 12 in. pipes, put between the Elements in the roof valleys outdoors.

The long row of apparatus pumps, with two driving engines, and extra R.F.Ts, with R.G.S. and L.G.S., and some extra A-frame Vacuum Pumps, gave us spare apparatus, and the Compressors increased the product from the C.Ls, which the completion of S.H. in Annex N° 2 enabled us to dry.

We averaged 200 tons of Ash in 1891, and 225 in 1892, with two Elements - 10 C.Ls.

lan 5736 1 & 2  
apt. 1901. *Note below* These plans show the N° 4 & 5 Apparatus Room, in sectional elevation, with a section of Tower, and view of C.Ls, which were all built of the designs which had been modified by experience until they had become much more efficient, and had greater capacity than any in use in Europe.

The A.Bs were of cast iron, which had displaced the old wrought iron type in N° 1 & 2 Elements, with overflows and passettes.

The L.G.I. was of the same type. The D.S. were of steel, with large central holes, outside overflows, and well formed fauxfonds and passettes. The R.H. was also well designed, with large overflow doors and passettes.

*Note - N° 4 & 5 Elements were built previous to 1901 because I had a job on the roof of 4 & 5 watching R.F.R.H. temps on 3-11-1901 from Oct 1898 to Sept 1899 - B.L.T. - 2/28/45  
From statement on bottom of p. 62 - I believe 4 & 5 were built during 1893 & 1894.*

G.S. Multiple Passettes:

an A large L.G.S., with multiple passettes of 12 ft. 6 in. diameter, and four compartments, washed the S.H. gas.

G.R.H. The first R.G.R.H., heating the liquor of the filter before entering the R.H., using internal cooling tubes and passettes to distill the condensate, was erected in N° 4 Element. *abt the year 1900.*

F.T. A.B. 3 R.F.T. were installed under the A.B. to cool the A.B. by circulating the A.B. liquor through them. Heat traps for saving steam from D.S. liquor were erected, using old boiler drums for each D.S., and milk of lime eggs.

Ls: The C.Ls had 4 large tube nozzle rings, one pasette between each, and 12 small tube nozzle rings with 2 passettes between.

an 2243  
6/1893  
5698

Tubular R.F.T.s were used for cooling the liquor to the C.Ls. These were located in the tower. Two Weiss Compressors were located alongside the Riedlers in each Element, to be used for preliminary carbonating the liquor in one of the C.Ls used as a C.B.

The washing of the columns, by using the one to be cleaned as a C.B. or preliminary carbonator, had been worked out in the S. A. Department by experimenting with D.O. liquor pumped through the C.L. At first this was not successful, as the scale took a long time to dissolve, with only the circulation of the liquid.

After one of these unsuccessful experiments, A.H.Green, Jr. who was working on them, suggested pumping air or gas through the C.B., and the system of regular changes of the C.L. to C.B., with the preliminary carbonation of the liquor, was worked out.

These buildings and apparatus were erected during 1893 and 1894, and the S.H.T. had been worked out and installed in N° 1 Element, so that by the end of 1894 the production averaged 300 tons of soda per day.

S.H.T.: The Solvays had been running some long cast iron cylindrical S.H.Ts in Europe, and sent us the plans, recommending that we install some of them.

Plan 1960 (3 parts)  
April 18, 1892

We worked out the plans in the Spring of 1892, and installed five of them in Element N° 1, moving the 8 S.H.

Plan 1960 shows the type employed, with cast iron cylinders 5 ft. in diameter, with buttstraps about every 14 feet, with rollers and tires at the ends and in the center where the furnace was interrupted.

A center drive at first, (by belt) afterwards, with direct-connected Straight Line Engine. A treffle feed for the B.C. into a double mixer, with a screw feed for dry ash and a chain in the S.H.T.

The fire was producer gas from Taylor Producers, using Anthracite coal, with a cyclone-shaped burner below the S.H.T., the gas being admitted through a sand-sealed valve from an underground flue. A special chimney East of N° 1 Element was built with a flue under the discharge end.

40" Rotary Conveyor:

479

The finished ash was discharged by a worm and pickups in the cylinder, into a 30 in. rotary conveyor, which delivered it to an elevator, which elevated it to 40 in. cooling conveyors above.

Feed of S.H.T.:

Plan 2531.

Oct. 25, 1894 The feed for S.H.T. was afterwards modified by putting a screw into the end of the cylinder and arranging an auger to feed the dry ash.

Plan 2531 shows the first effort with a vertical auger feed for the B. C. above the floor, and a scraper conveyor above to deliver the B.C., and a side opening to use when surplus B.C. was to be fed.

Plan 2847  
5/1895.

This was afterwards modified like Plan 2847, to get the B. C. Feed down close to the ribbon worm and below the floor so that the B. C. could be fed in from piles.

The first feed table was loaded directly under the conveyor, a layer of B.C. being continuously supplied, and a scraper knife diverting it over the edge to fall into the hopper below. These were forerunners of the modern closed Feed Table.

The very low yield of the B.C. from the Vacuum Filter made it necessary to add a very large amount of return ash.

We installed a chain conveyor designed by the Link-Belt Company, which received the ash from the discharge end, carried it back up an incline to and along the feed end and returned it to the elevator, completing the circuit.

The B. C. was collected and delivered by a scraper chain.

Plan 2106,  
18/1893

To remove as much of the liquor and water as possible, and to get rid of the shoveling out of the filters, we put in 24 Weston Centrifugals, with mixers over them designed by the American Machine Co., like sugar refining machinery.

These Centrifugals reduced the moisture to 6 - 7%, and we washed the liquor out by giving a dose of water just after the liquor disappeared.

The machines were the best which could be obtained; they operated as well as sugar house centrifugals usually do, and dried the B.C. to 6 - 7% moisture. Their capacity was limited to 12 tons of Bicarbonate, equal to  $6\frac{1}{2}$  tons of soda per machine per 24 hours, or 156 tons per day, for 24 machines.

This took 12 men, at \$1.50 per day, to empty the baskets and charge, and the power to run the mixer and centrifugals was very high. The repairs were also great, as the Ammonium Chloride attacked the baskets and curbs where the air was blown against them. We finally gave these machines up and moved them to the B. C. Department.

ARY FILTER: The next improvement was the Rotary Filter. We had nearly 100 men per shift, shoveling B.C. from the filters, and shoving cars to deliver to the S.H., with the centrifugals and conveyors. Part of these were eliminated, and the 5 S.H.T. dried about 125 tons of soda, so about 50 men were eliminated, and 36 added for centrifugals. The saving in labor was therefore not great.

In May 1894 we sent J. Wm. Smith over to study operations in Europe. While in Brussels he saw a little drum 3 inches wide and about 24 inches in diameter, revolving in a tank in the Laboratory. When a vacuum was put on the drum it picked up the Bicarbonate suspended in a mixture in the tank, and a knife fixed on the edge scraped it off. This was called the "American" Filter, as they said the idea had come from the United States.

Mr. Smith took notes and a sketch, and wrote a report to us at once, as it was a novel idea to him.

In his program of improvements, dated September 1886, written during his visit here, Ernest Solvay mentioned "A Continuous Filter, such as a drum," and perhaps he carried the idea home with him.

n 2450  
4/1894

The value of this idea, reported by Mr. Smith, was immediately recognized, and an experimental filter was made at once. We found in Syracuse a drum of cast iron, with wrot iron sides, and a trunnion on one side, perforated with 1 inch holes 2 in. center to center. We cast some side pieces for bearings, with stuffing boxes and place for stirrer and gears. See Plan 2450, and arranged a stirrer with crank and driving shaft, and had a base tank made with bearings on its edge.

n 2525  
18/1894

This apparatus was in run in a very short time - about one month- and was so successful that we commenced the design of a complete Filter. See plan 2525, from which we had a

number built as rapidly as possible, and soon eliminated the filters, and eventually replaced the centrifugals.

As will be seen from the plan the first filter had no backwash, had a perforated pipe for washing, and an adjustable knife, which had to be moved every 20 minutes to cut off the glaze on the bed, made by the knife, which stopped the picking up of the B.C.

We later added a connecting rod between the stirrer arm and the knife, which gave it a continuous motion, which eliminated the cutting off except at intervals of three or more hours.

This Filter was made with a slotted cylinder, which was cut by Professor Sweet on a new machine he had built like a huge milling machine. Plans sent over to Brussels, with a report of the operation excited a great deal of interest, as they were still studying the little filter in the Laboratory. They developed a machine with a back-wash, which we finally adopted, but the filters like above plan gave us very good service for many years

tary Cooling Conveyor:

an 2402 3/10/1894.

an 3391  
17/1896 The chain conveyor about the S.H.T. for handling and cooling Ash, made so much **noise**, took so much power, and broke down so often that we were forced to develop something else; to cool the ash, convey it, receive it from the S.H.T. and deliver it to the feed end of the S.H.T., then distribute it to the large number of B.Ls with as little power and dust as possible, was quite a problem. We gave a great deal of study to various methods, but finally hit on the scheme shown completed in Plan N° 3391, and in detail in Plan 2402.

A transfer station between double lines of 40 in. conveyors, running across all the Elements located at the center of each Element, was devised, which could receive, discharge, transfer straight along, or to the conveyor alongside of it.

The Rotary Conveyors were 40 in. diameter, and ran on tires on double rollers. Each station had a kind of stuffing box. 30 in. Rotary Conveyors were used in each Element, to take back a portion of the Soda coming up in the elevators, to an inclined bin, with a scroll conveyor to distribute to S.H.T. Feeds, and to divide the Soda into two parts so that one-half went to the 40 in. conveyor, and the other half to return ash to S.H.T.

Jan 3391 The end of the 40 in. Conveyor was extended to cover the 3 Soda Storehouses, when they were built. The soda was delivered into hopper scales, weighed by a man in attendance and transferred to the storehouse. It was taken out of the storehouse by a Rotary Conveyor under the store, receiving in numerous stations under hopper; a power scraper dragged the soda from the end of the building into the hopper; it was conveyed to an elevator and elevated into a second hopper scales and returned to the conveyor to be transferred back to the B.Ls to be mixed with the hot soda and packed.

The conveyors side by side conveyed in opposite directions, and the transfer stations allowed it to be delivered into B.Ls at the center of each building 72 feet apart, or sent forward to the next, or circulated around to give more time for cooling.

A draughtsman named Guilbradson, who was employed in the design of these conveyors, was entitled to much credit for clever carrying out of ideas given him. He applied for patents on these ideas, but it was shown in the interference case that he was not entitled to the patents, which were given to the Company.

The conveyors of the above type are still in use at Detroit, but have been changed at Syracuse when drying room was rebuilt to two systems instead of six, and the stations and rollers improved. It is a very satisfactory way of handling and cooling ash.

The scales have also been changed to Automatic Richardson Scales, and Elevators re-arranged to give better service. A 30 in. Conveyor was also installed to deliver soda to the C. S. Plant, and a 20 in. scroll conveyor for the soda storehouse, so that both could go on at once.

an 1266 LIME KILN } see p. 47 *Chapter IV*  
 2316.  
 /27/1893.

Plans 1266 and 2316 shows the improvements made in lime kiln and M.L.T. Plant, by the increased height of the kilns, and the new M.Ls.

32 kilns and 10 M.Ls were served by the cable road from Split Rock, and except for the labor of handling the buckets on top and cars of lime below, were quite a good type of simple kiln, giving gas of 37 to 38%, and well burned lime, with 9 to 10% of coke.

The milk of lime was screened and delivered to the D.V. as a storage reservoir, drawn to lime eggs and pumped direct from them to the D.S., with individual apparatus pumps with regulated strokes.

ILERS:

Nº 2 Boilerhouse and chimney was built; boilers of B. & W. type were set much higher than Nº 1, and had individual economizers between each boiler, made like the boilers with headers and iron tubes. These tubes were treated by the Bower-Borf oxidation process, but gave trouble from pitting.

A water purification plant was installed, using soda and sand filters to treat the lake water, which was heated with exhaust steam, and steam from the D.S. heat traps, drawn through an open heater by means of a vacuum pump. The purified water was stored in cisterns under the boiler house, and direct-acting plunger pumps fed the boilers.

Buckwheat anthracite coal on Mc Clave shaking grates, was burned with forced draft from fans at the ends of boiler house, supplemented by steam blowers.



L STORAGE: A coal handling plant for storage, with a conveyor over a conical pile on trusses and through a tunnel stored and rehandled the coal into cars. This pile was 80,000 tons capacity.

le Pump Water Supply:

The increased product required increased water supply, and the lake pump was increased, first by an additional 30" pipe out into the lake, with 10,000,000 gal. high duty direct-acting Worthington Pump, and then a 12,000,000 gal. Riedler Pumping Engine, with the necessary boilers and increase of building. For the latter pump a 42 in. pipe was put out into the lake, and a well was dug, with syphons to keep it supplied with water, the pumps all sucking from the well so as to avoid the pulsation of the very long suction pipes.

A set of 24 in. delivery pipes were laid down and connected to the two water tanks over N° 1 Tower, which were also connected to each other overhead. The last pipe was difficult to put in, as a ditch 30 ft. deep and 500 ft. long had to be dug through the D.S.Waste. The walls of this ditch however, stood vertically, and cut like old cheese, so that no sheet piling was required, and we put in the pipe without trouble.

The laying in the lake was done by Thatcher & Bremer, a diving firm of Toledo, Ohio, who put five lengths of the pipe together in sections, having every fifth length with the bead turned off and drawing the joint apart, then re-jointing it under water by clamps and bolts. An iron end box, with a rod grating, which could be removed by lifting with a grapbell from above, and had a set of guides so that it could be easily replaced, was fastened on the end of the pipe in 60 ft. of water. This was very useful later, as the D. S. Waste over the pipe leaked into it a little in places, and formed a scale which grew at the joints on the inside until it reduced a 42 in. diameter to 12 inches in

places. We removed this above water level by sending a man in with a little car, which was used to draw the debris out, but below the water level was a problem. We finally invented a cleaning device, consisting of two half balls, rotating on a shaft attached to a wire rope, so that the half balls could revolve in opposite directions when propelled by the spiral angle iron coiled around the half balls in opposite directions. The balls were made of wood for the 30 in. and 40 in. pipes. They were introduced into the pipes at the well, the wire rope passed through a small stuffing box and attached, and the pipe closed up. A 12 in. pipe was connected to the pipe to be cleaned, and the Knowles fire pump connected and started.

The water flowing by the balls acted on the spiral blades revolving the half balls in opposite directions, and the pressure moved the balls along, and the blades cut out the scale so rapidly that we cleaned 1000 feet of pipe in three hours.

A diver at the end notified us when the ball appeared in the cage, and the length of the wire rope used also warned us of the approach to the end. A windlass on the rope regulated the progress of the ball in the pipe and drew it back to the starting point.

We cleaned both the 40 in. and the 30 in. pipe in a very short time, using the other to furnish the water to the Works, and to pump into the pipe behind the ball.

As our production had been limited by the amount of water which we could get through these pipes we had to slow down while cleaning, and we had to clean them quickly to prevent slowing down the Works, especially as summer was approaching. The use of the ball was therefore a happy solution of the problem.

The production of Soda was steadily increased as we put in more Reidler Compressors and remodeled our C.Ls, averaging per day 330 tons in 1895, 340 in 1896 and 420 in 1897.

Plan 3931. The No 4 & 5 Elements were provided with 3-bearing S.H.T., modified from those in No 1, as we had more experience.

The gas burners were improved, the feed was modified as described above, and the Rotary Filters improved giving about 44 yield of the B.C.

The half of the cylinder between the center bearing was increased to 6 ft. in diameter to give a deeper bed of Ash to receive the wet Bicarbonate to prevent scaling, and the chain was improved; also the stuffing boxes at each end.

Plan 3931 shows the complete S.H.T. as it was used after the feed was modified, by having an open scroll instead of a conveyor in pipe.

Plan 4877. Shows the different types of cylinders tried, which were finally superseded by the steel cylinders without center bearings, now used in the 2-bearing modern S.H.T. The cylinders are now made of one welded tube.

Plan 4608.  
5/23/1899. This plan shows the first effort to measure the B. C. and Ash more carefully to produce a regular feed.

Plan 4648.  
5/31/1899. This plan shows the first feed table. This feed table was followed by a closed feed table. (See Plan No 4931) which was still further improved by driving the cylinder above the table separately on a ball bearing <sup>Plan-15960</sup> to eliminate the center supporting wings, which obstructed the flow of B.C. and accumulated crusts that prevented accurate feeding.

Mr. Tracy afterwards worked out an inclined spout from the conveyor, which feeds the feed table automatically, and can be easily cleaned.

The S.H.T. in use in the old Elements did not have the advantage of recording pyrometers and automatic draft regulators they now enjoy, but we did use an expansion indicator, which showed the expansion of the half of the shell next the feed end.

The Taylor Producers were increased in number until we had 32 in use, and 16 of them were modified so they had a stationary table with a revolving knife instead of a revolving table. This very much improved the gas and cut off 16 men per day from the labor on one-half the producers.

The gas burner shown in Plan 3931 was afterwards also used at Detroit with Mond Producer gas.

The packing was done with screw packers instead of jumpers, and these were redesigned so that the gearing ran in oil to give longer life and greater efficiency.

The distillation was improved by the design of an R.H. with 7 small passettes instead of one large one, and the cooling tubes, which heated the filter<sup>liquor</sup> in half the rings and cooled the gas with water in the last pass of the gas, which is now known as the R.H.C.D., very much increased the capacity and the efficiency.

We also tried an apparatus called the C.G.S.H., which was interposed between the R.G.S. and L.G.S., in which the F.L.Liquor was heated by the S.H.T. gas before it went to the R.H. This apparatus absorbed some  $\text{CO}_2$  and saved some heat, but lost  $\text{NH}_3$  to the L.G.S. and was abandoned after careful tests.

We gradually worked up the production to an average of 415 for 1898, 500 for 1899 and 700 for 1900. The cost of Ash went to \$8.60 per 1000 kilos for the 500 tons made per day for 1899, and the production for 1900 was a record production for several years afterwards. The four Elements, with N° 3 Apparatus Room and the 2 Annexes, was the limit, and we thought 700 tons a maximum for the Syracuse location; it did not seem possible to carry the Element system any further on the property.

The distillation of the B. C. in the M.C.D.S., to make M. C. Liquor for Bicarbonate and Caustic, helped increase production.

The Mac Tear Furnace proving inadequate to densify the Ash needed to supply the glass manufacturers, we began to install Rotary Densification Furnaces fired with producer gas, and built three in all, provided with 40 inch rotary cooling conveyors below, with elevators, and a 30 inch rotary conveyor over the roof above, to deliver cool ash to the special B.Ls we used for the Dense Ash.

These furnaces were dusty, and we lost some ash up the stack, but had large capacity, and worked so well that we abandoned the Mac Tear and took it out.

These furnaces were afterwards used at Detroit until the Water-Dense System was started there, when all of them were abandoned.

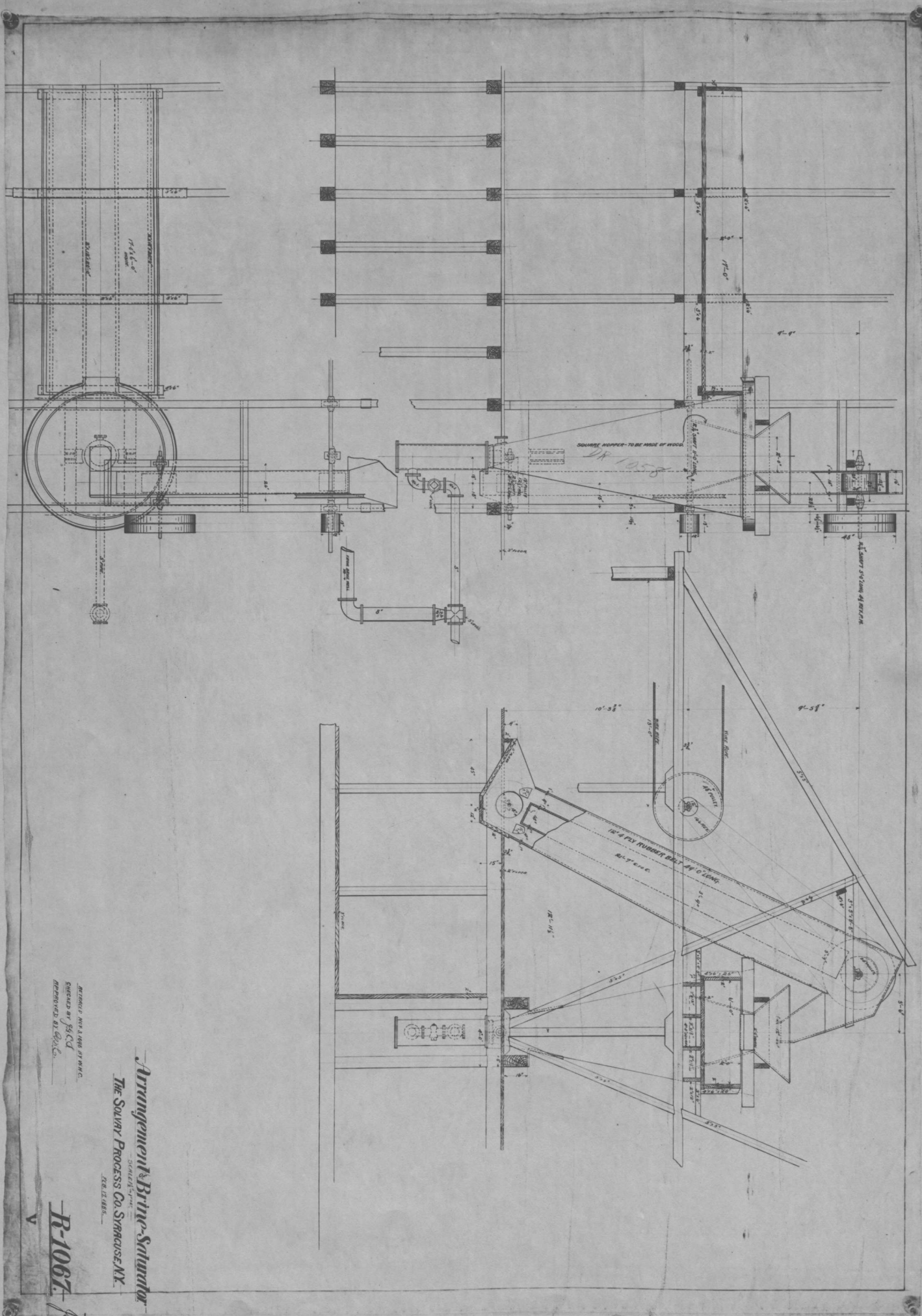
The rapid improvement in apparatus and in operation and cost was due to a united staff, which worked together.

The Participation Contract made us all feel that it made little difference who suggested improvements, they were all for the common good, and there was little of the jealous secretiveness which is so often seen in organizations where everyone is afraid that the other fellow will get the **credit** which belongs to him.

The development of Refined Bicarbonate and Caustic manufacture will be the subject of other chapters.







DESIGNED BY H.C.C.  
 DRAWING BY H.C.C.

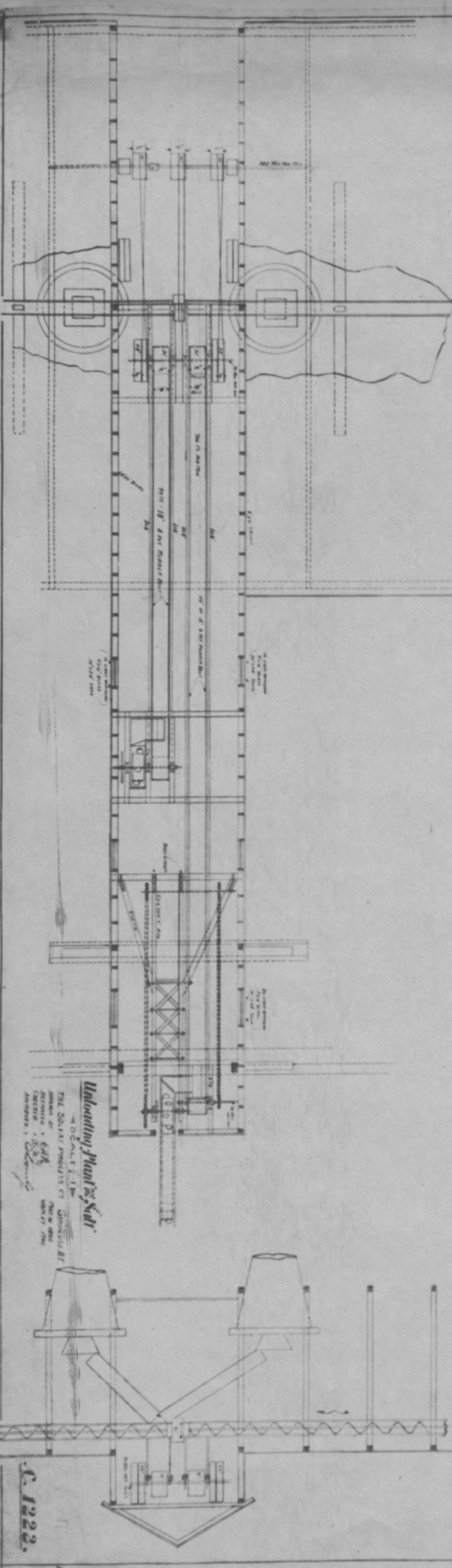
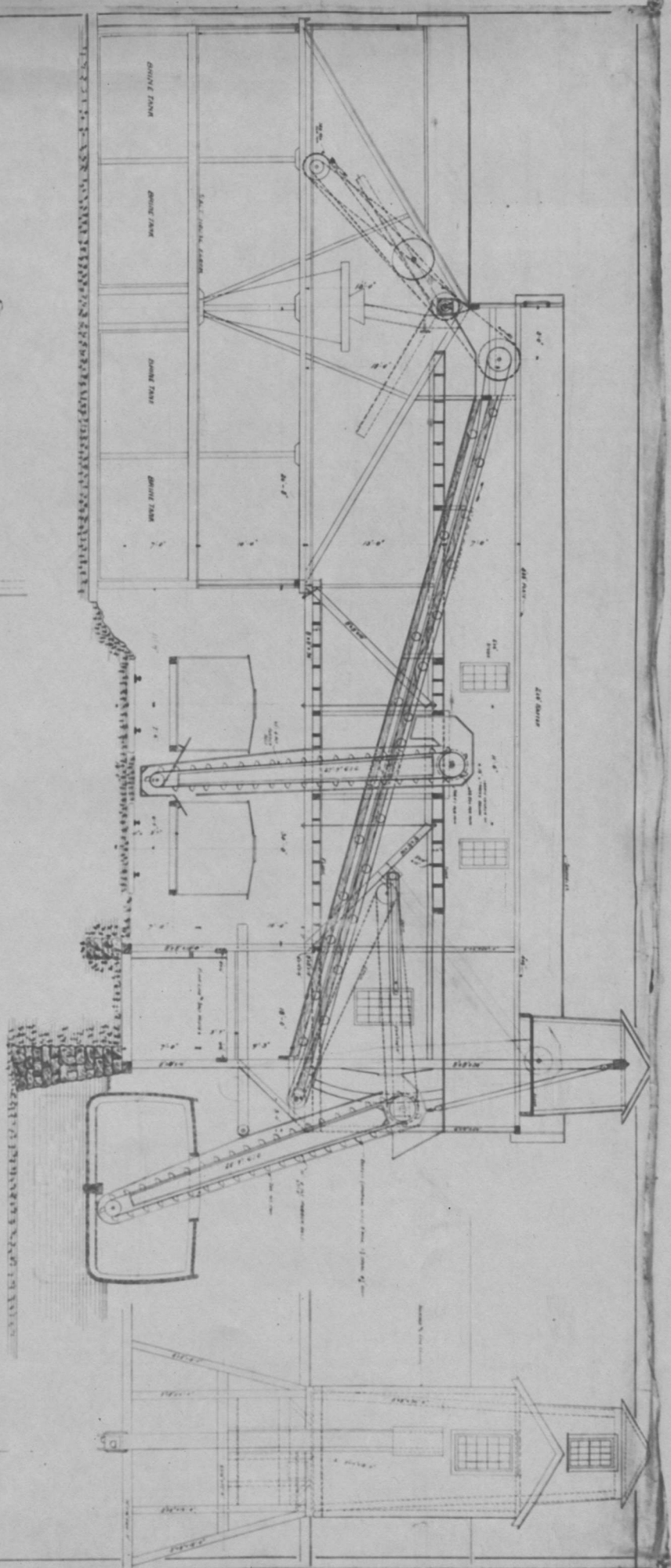
Arrangement of Brine Saturator  
 THE SALT PROCESS CO. SYRACUSE, N.Y.

R-1067

V. 1052

Salt House - Brine Saturator

R-1067 = V. 1052



**Unloading Plant for Salt**

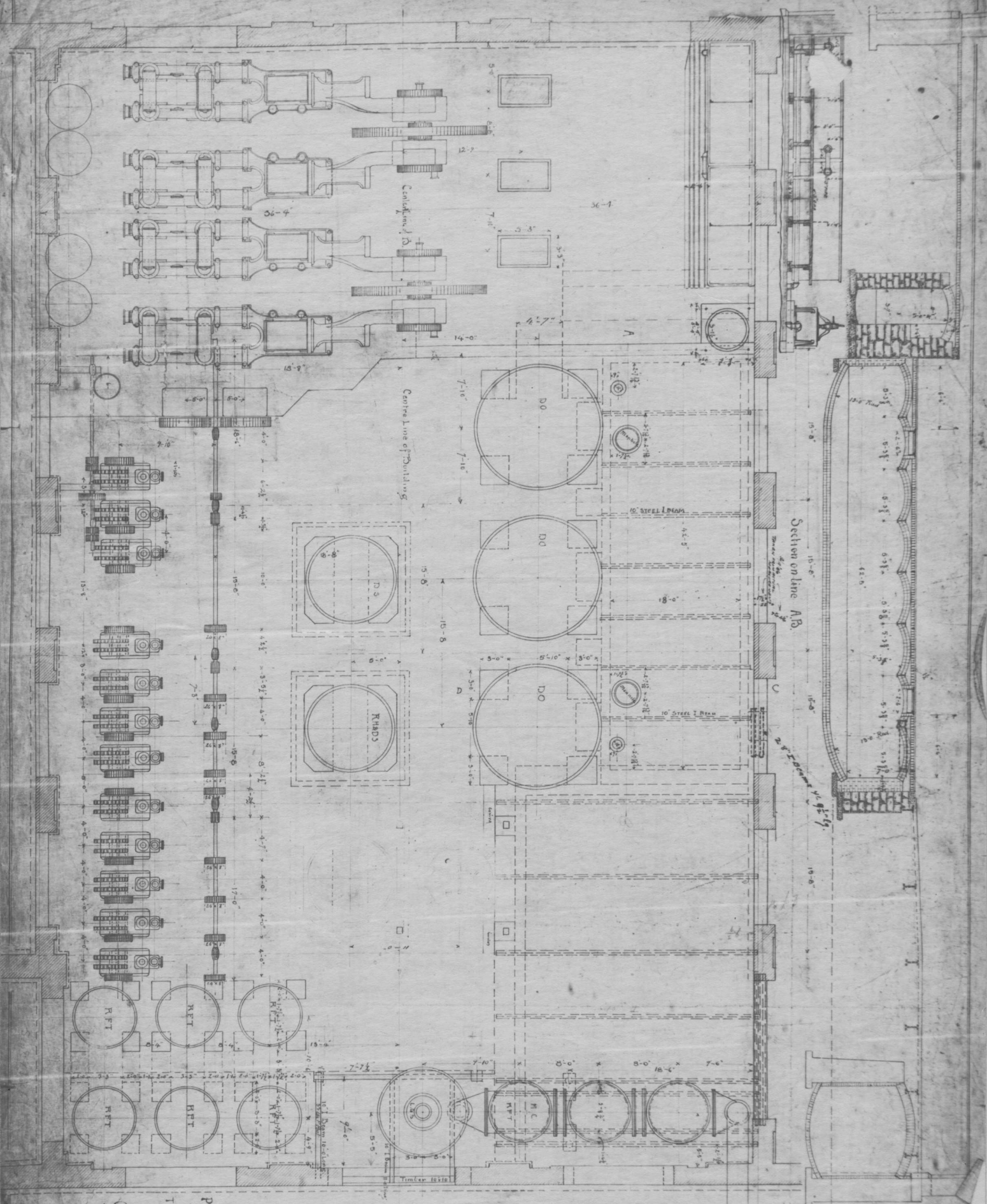
THE SOLAR PROCESS CO. CHICAGO, ILL.  
 ENGINEERS & ARCHT.  
 1922

C-1222

V  
 53

C-1222 = V-53



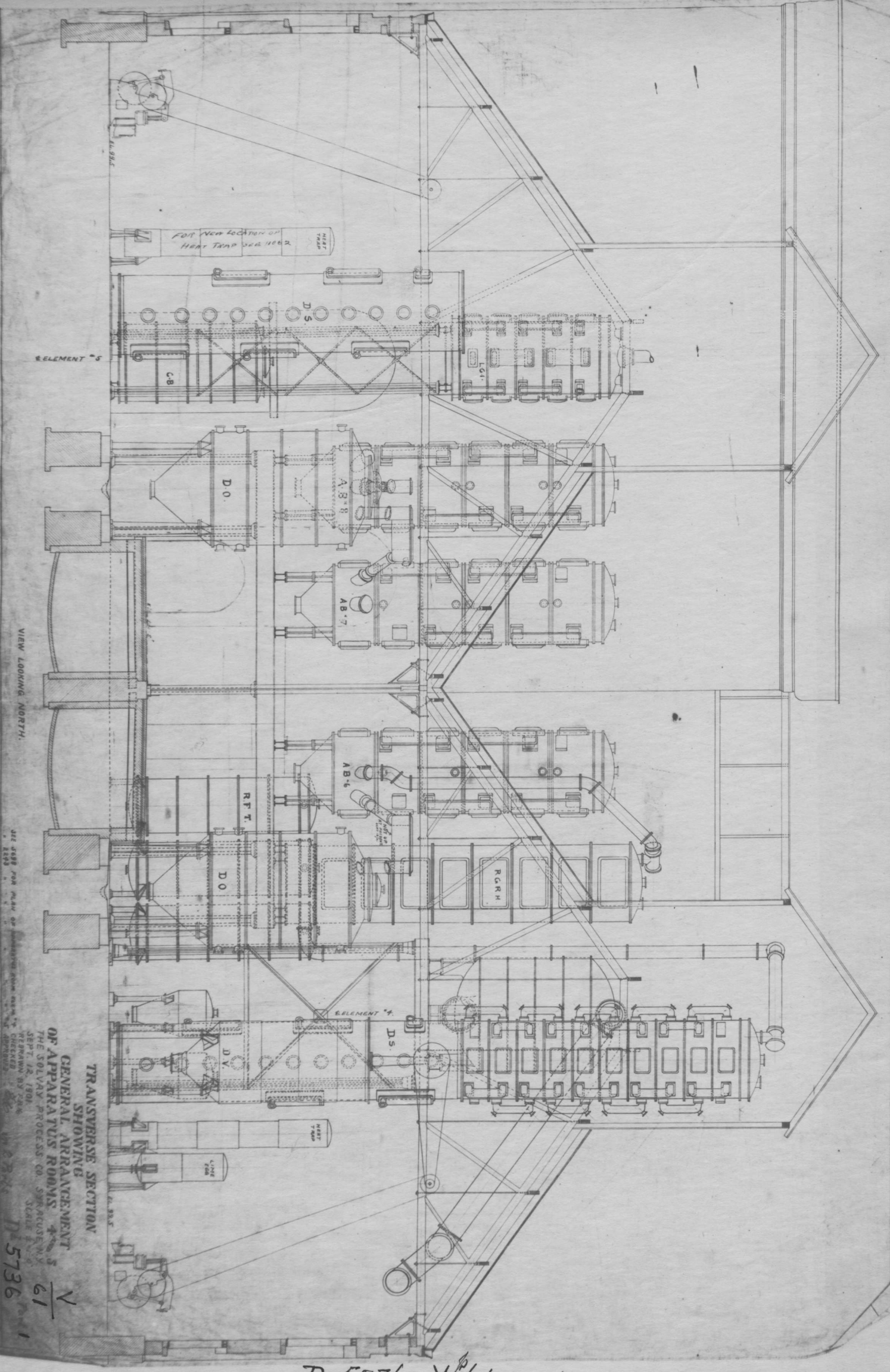


PLAN of GENERAL ARRANGEMENT  
 APPARATUS ROOM No. 5.  
 THE SOLVAY PROCESS & SYNGAS  
 RETRACED FROM DRAWING DATED  
 APRIL 26 - 1891.

D. 1751,

V. 60

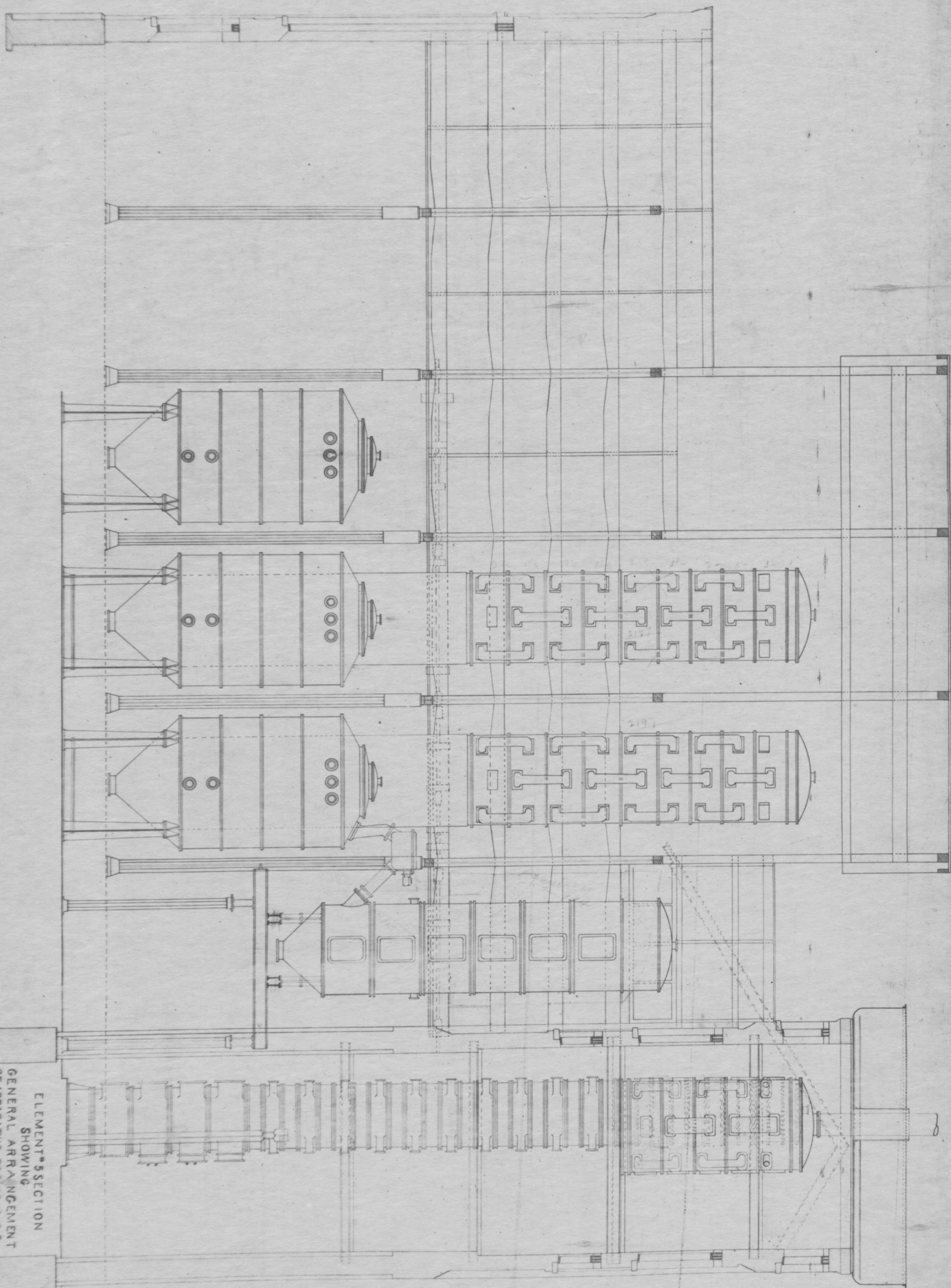
D-1751 = V. 60



D-5736, V. 61



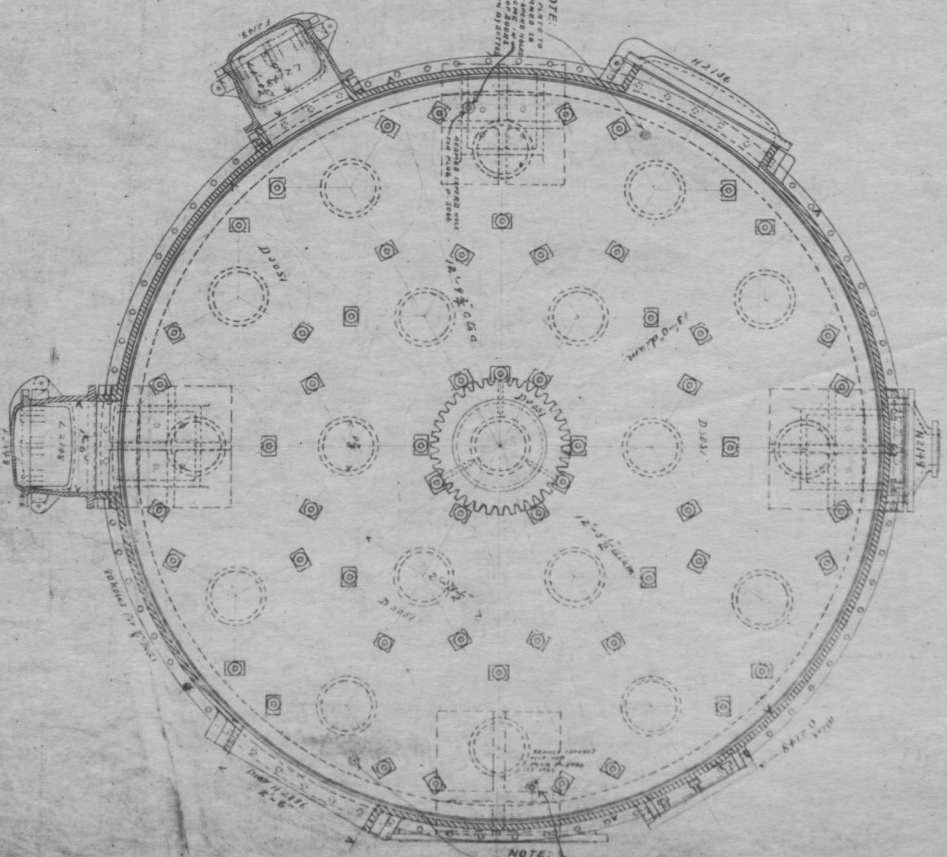
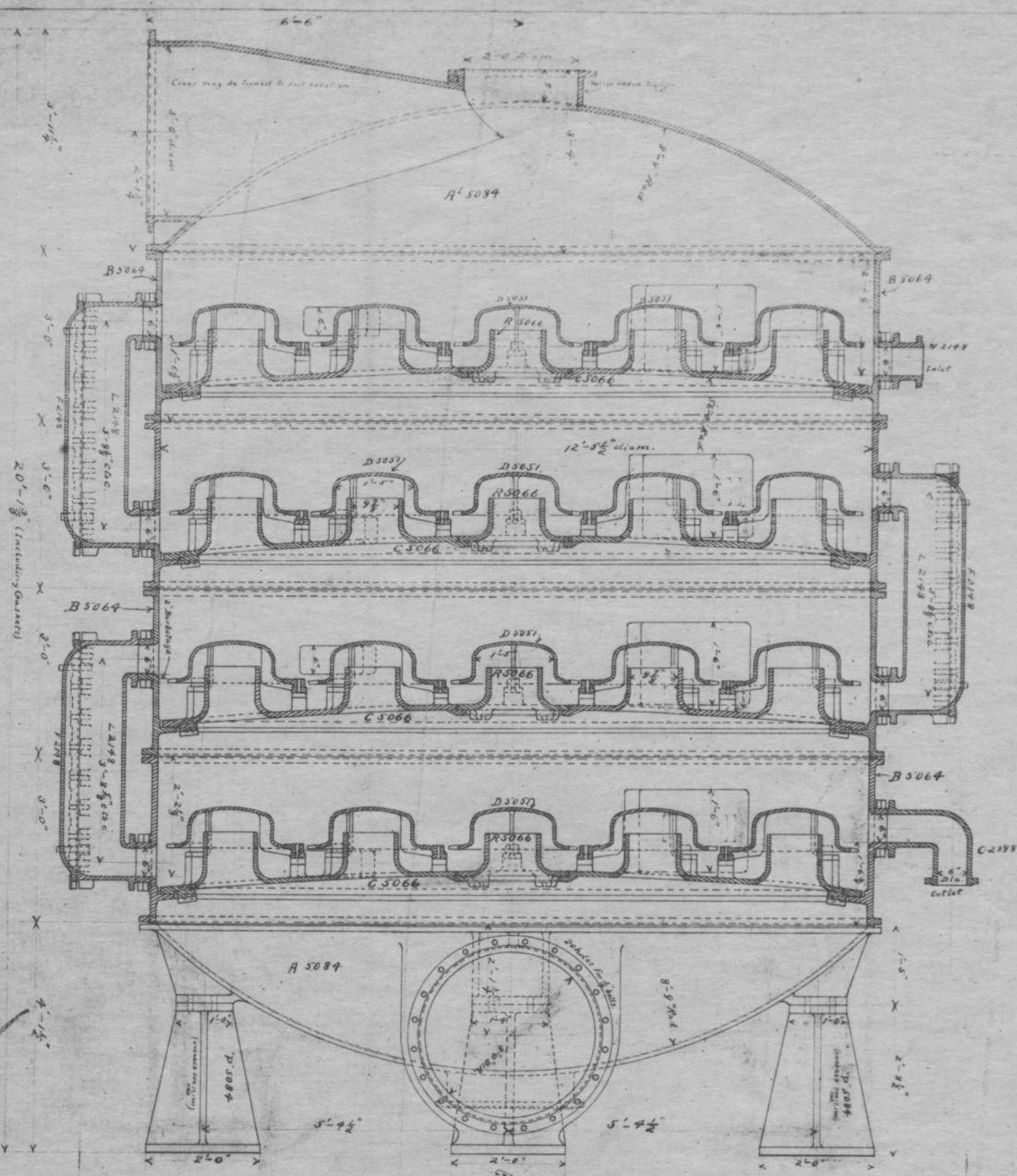
South



ELEMENT 3 SECTION  
SHOWING  
GENERAL ARRANGEMENT  
OF APPARATUS ROOMS 4th S  
THE SOLAR PROTECTOR SYMPOSIUM  
TRACED BY MS  
CHECKED BY MS  
APPROVED BY MS

7/2/61  
D-5736  
12/2/61

D-5736<sub>2</sub> = V.461



APPARATUS L.G.J.  
FOR DETROIT.  
12'-5 1/2\"/>

N-5055-V-p62

For Location, See 5112

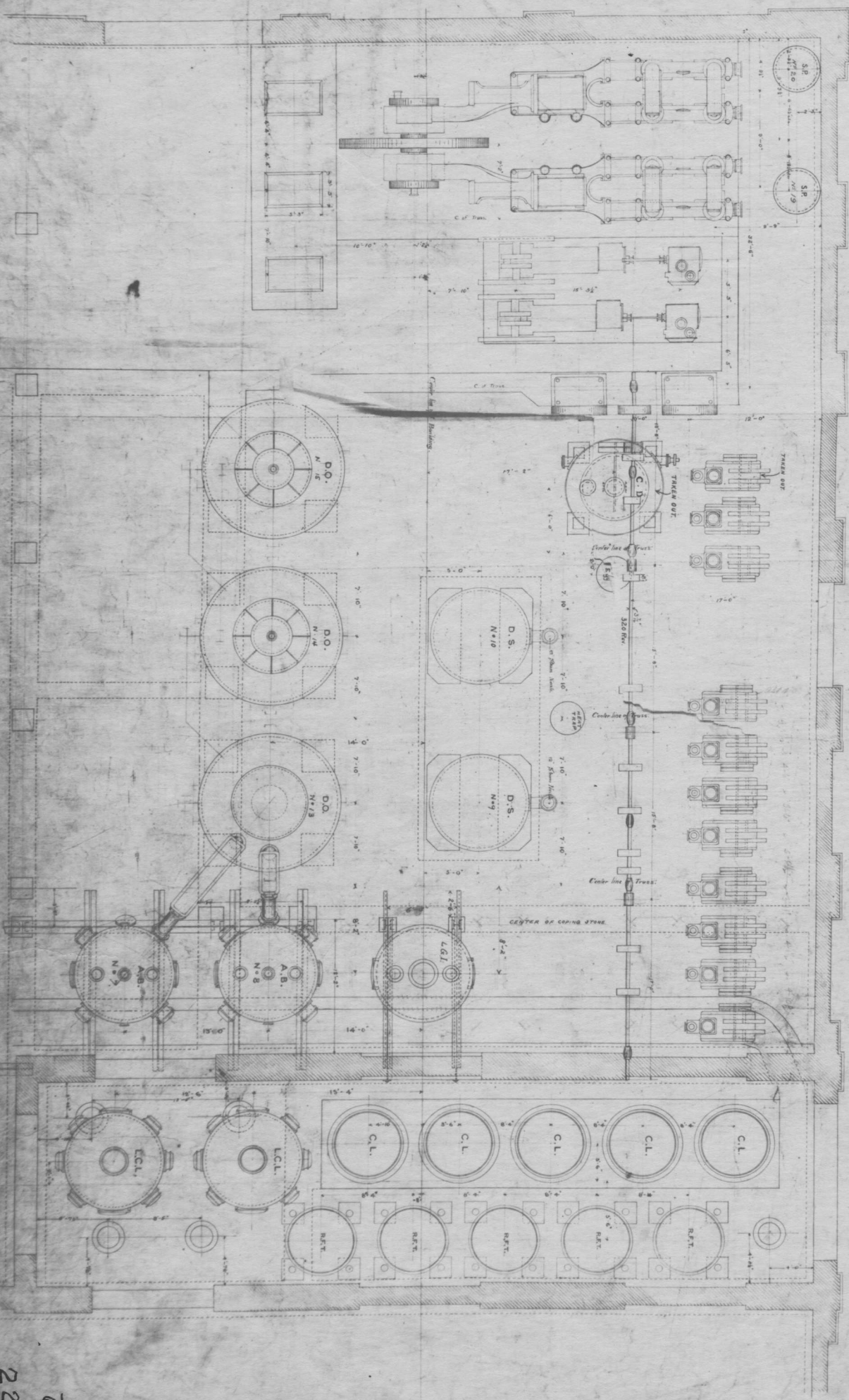
N-5055



South

PLAN

W 208

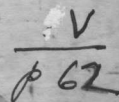


General Arrangement of Machinery  
The following figures are of the same  
Scale as the plan of the ship

2243

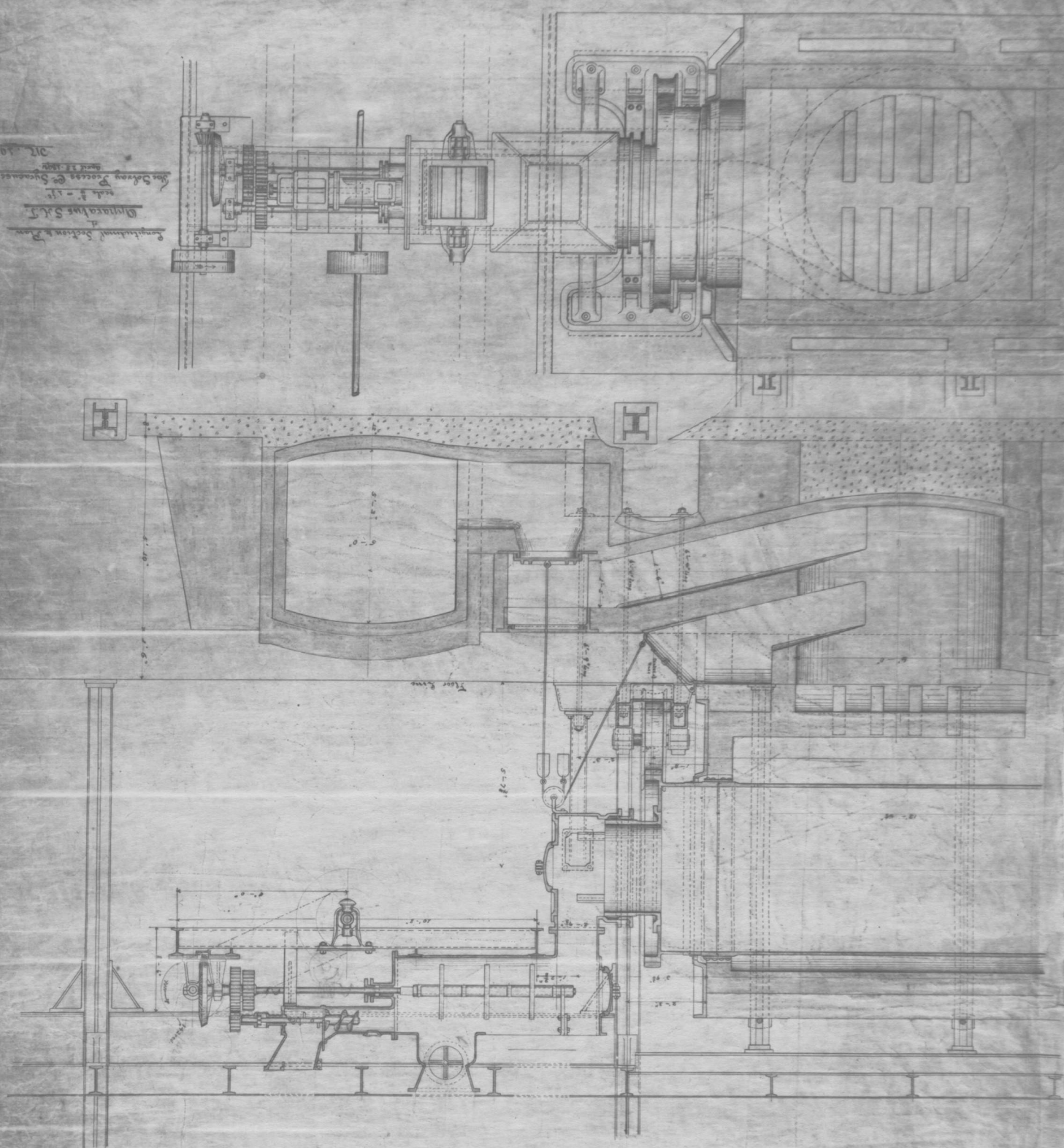
1/2

2243 = V. 662



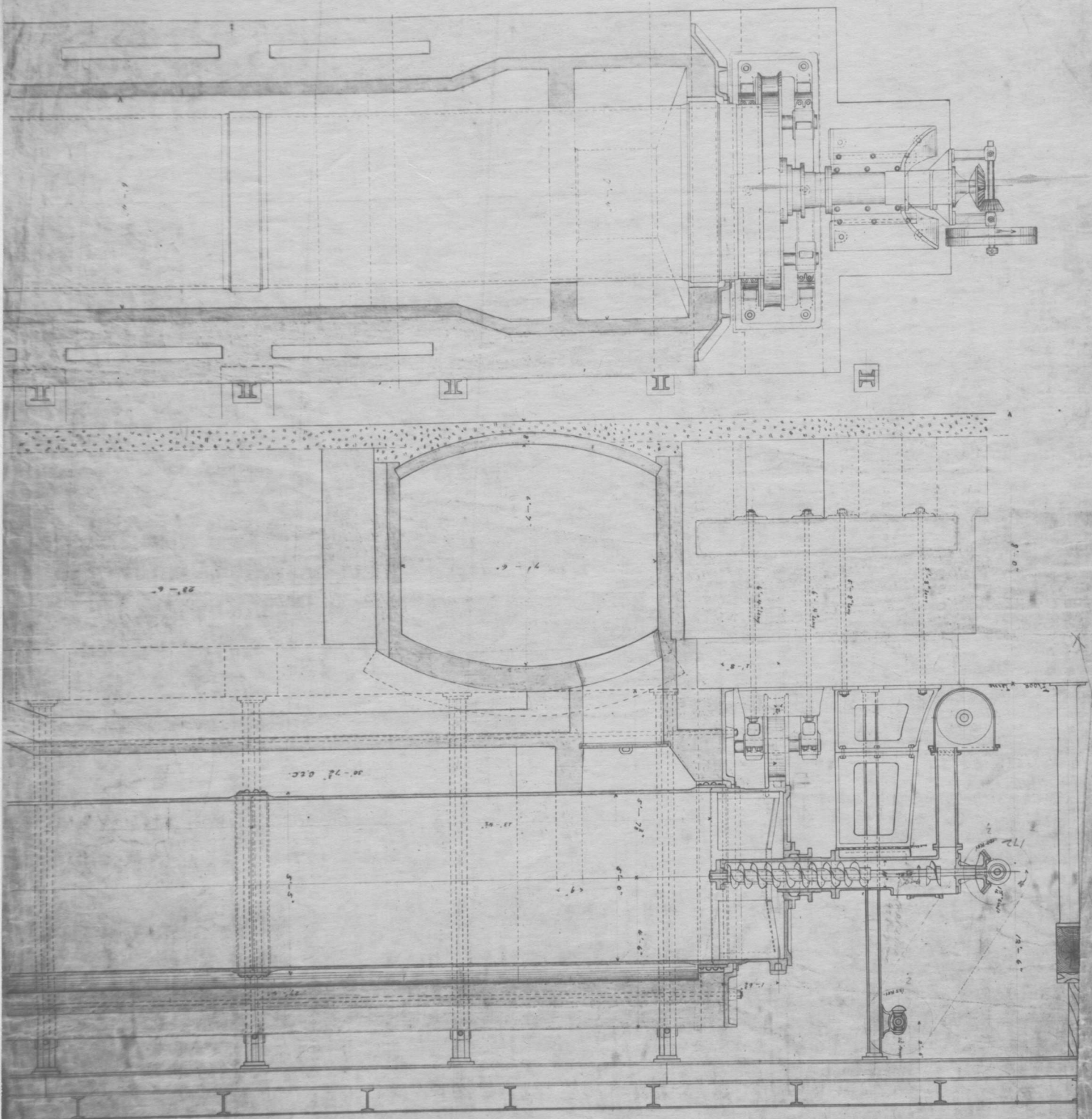


Longitudinal Section B-B  
 of  
 Apparatus S.H. 5  
 Scale 1/2" = 1'-0"  
 May 12, 1960  
 J.E. Sawyer & Co. Engineers, Inc.  
 317 1960



M1960 Part 1  
 63  
 V

M-1960, = V. p63



M1960 Part 2

63

M-1960<sub>2</sub> = V. p. 63



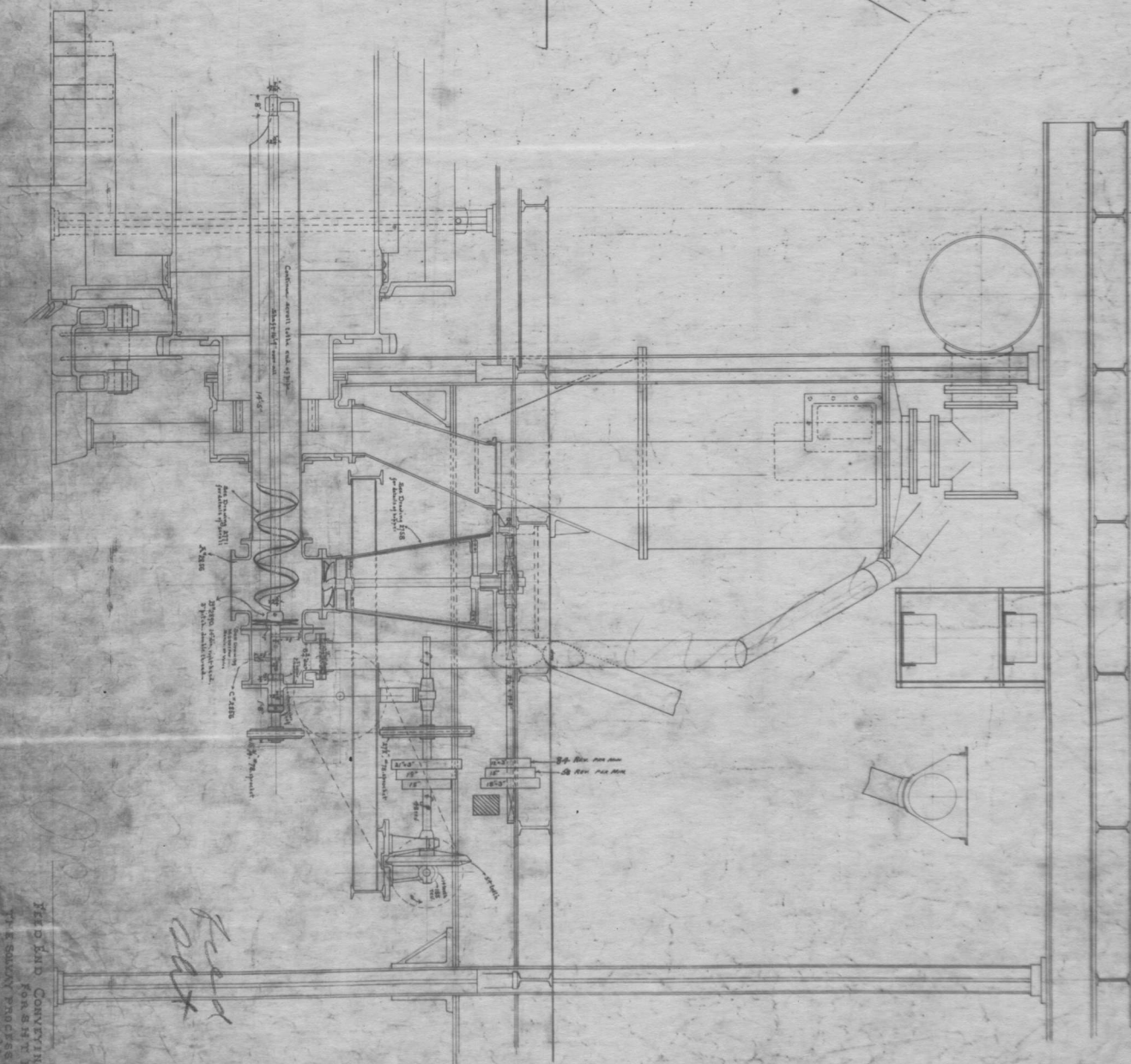
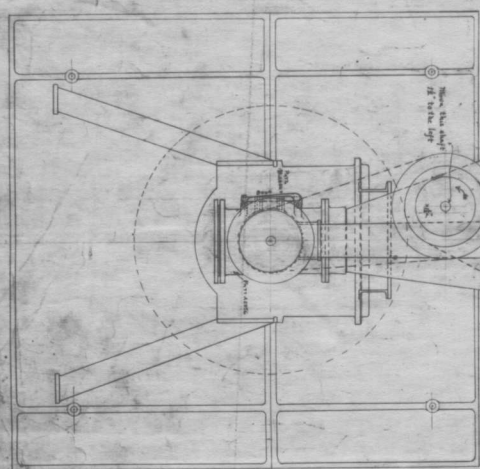


M-1960<sub>8</sub> = V. p 63





2000



2847  
2847

FEED END CONVEYING ARRANGEMENT  
FOR S. M. & S. CO. S. M. & S. CO.  
S. M. & S. CO. S. M. & S. CO.

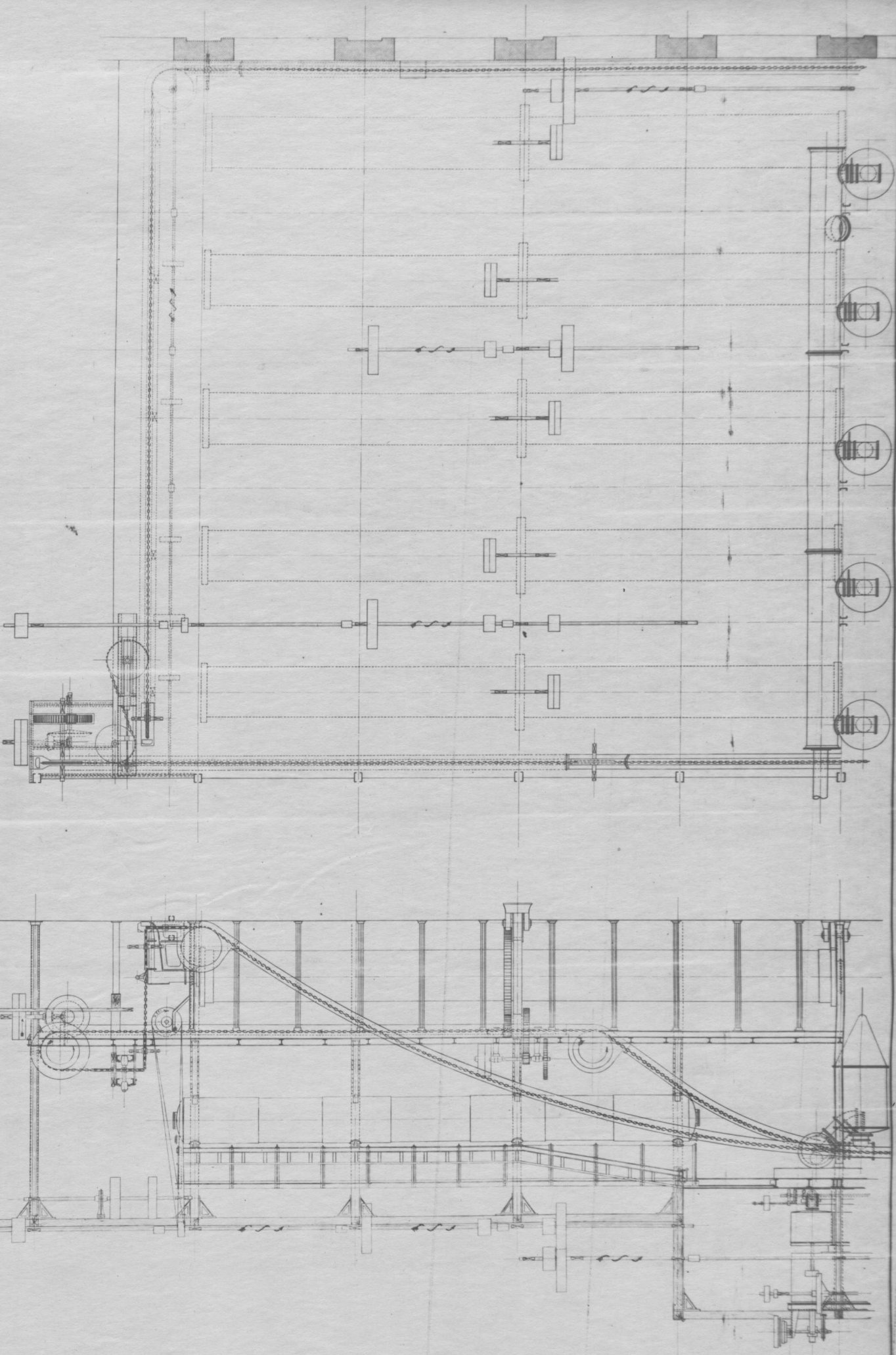
2847

✓ 64

2847- V. p. 64







General Arrangement of S.H.T.'s, Centrifugals, Conveyors &c.

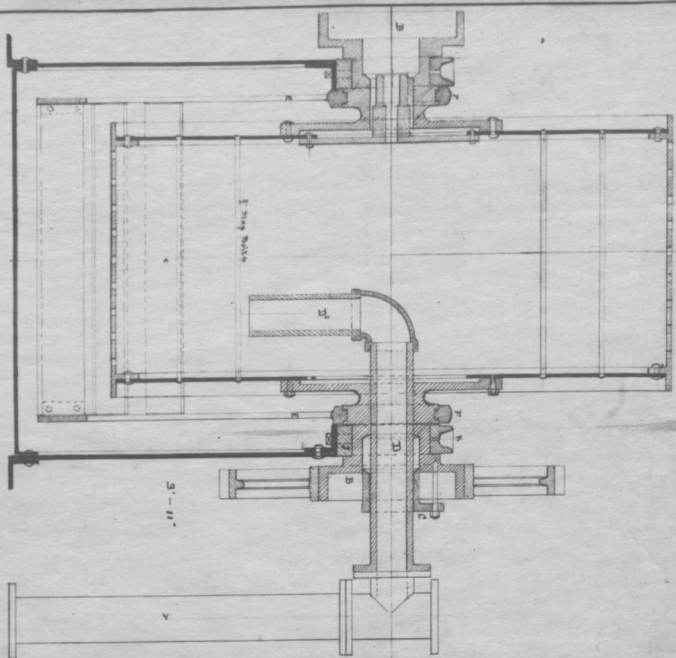
Element No 1

THE SOLVAY PROCESS COMPANY,  
 SYRACUSE, N.Y.  
 DESIGNED BY AGI.  
 CHECKED BY AGI.  
 APPROVED BY AGI.  
 IN TWO PARTS PART 2  
 JANUARY 18, 1925  
 D-2106 II

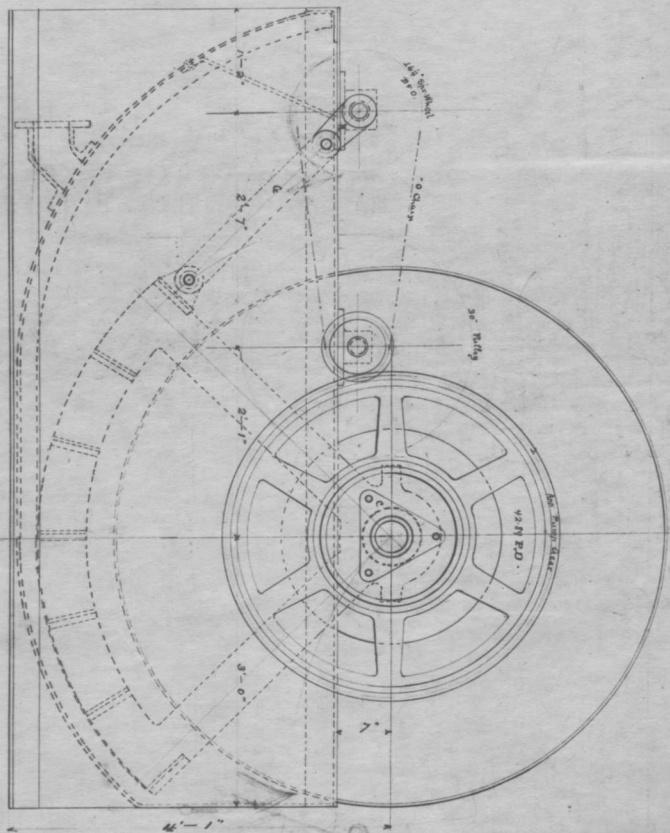
D-2106, - V. p64

64

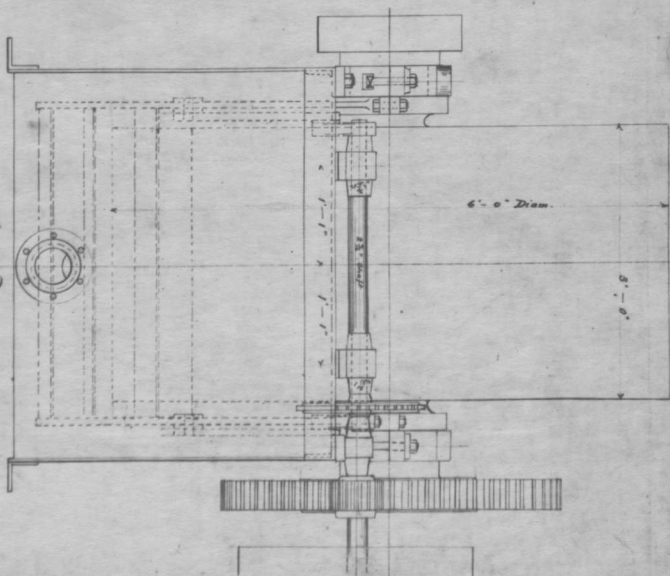




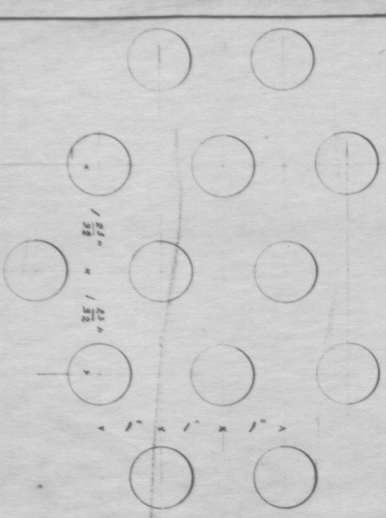
Section through Center.



Side Elevation

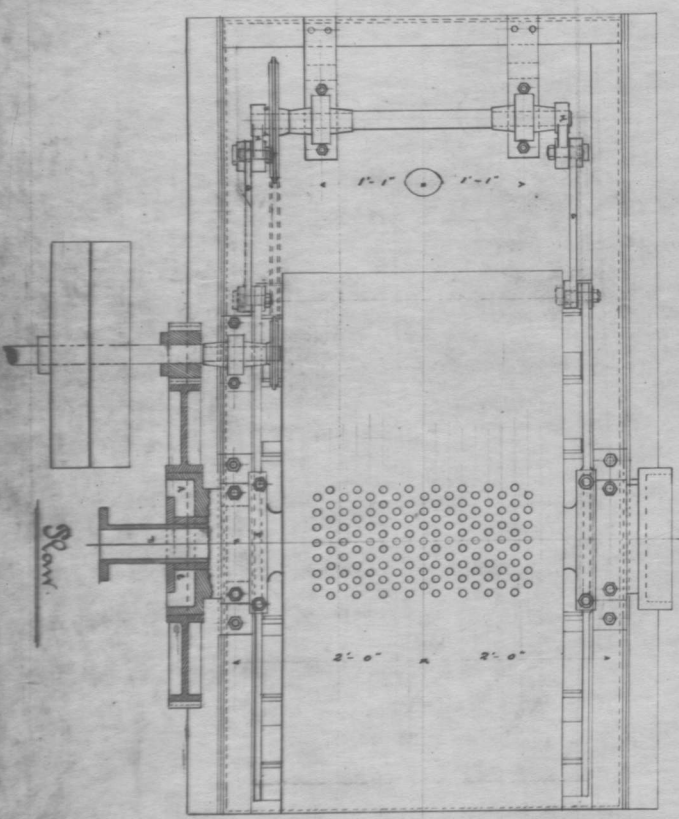


Front View



1 5/16" x 1 5/16"

Detail of Soling Machine Detailing, Jan 5 1914



Front

Drawing of S.E. Soling  
Scale 1/2" = 1"  
Sole Soling Success Co. Syracuse N.Y.  
June 11, 1914  
2450

2450  
V. 65

2450 = V. p65





East End.

View Looking South.

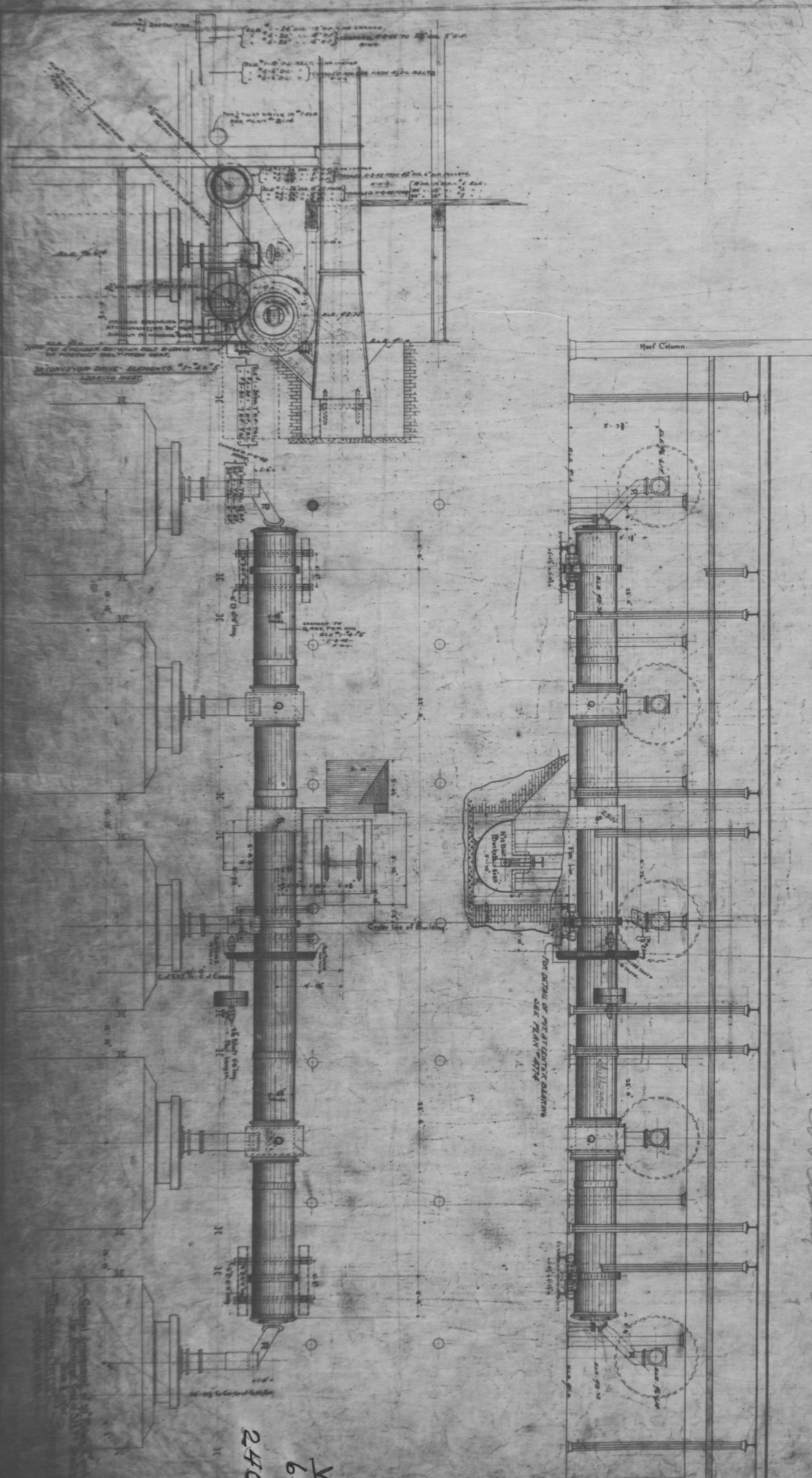
View Looking East.

D-2402 = V. p66

— Arrangement for Driving 40  
Double Flange, Concrete, Steel  
The Solvay Process Co. Syracuse  
N. Y.

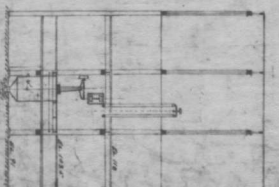
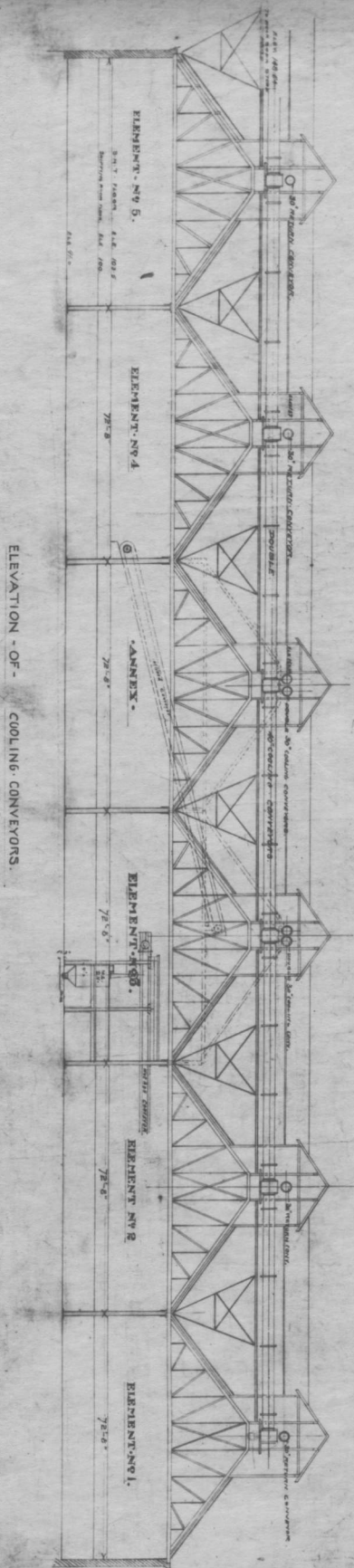
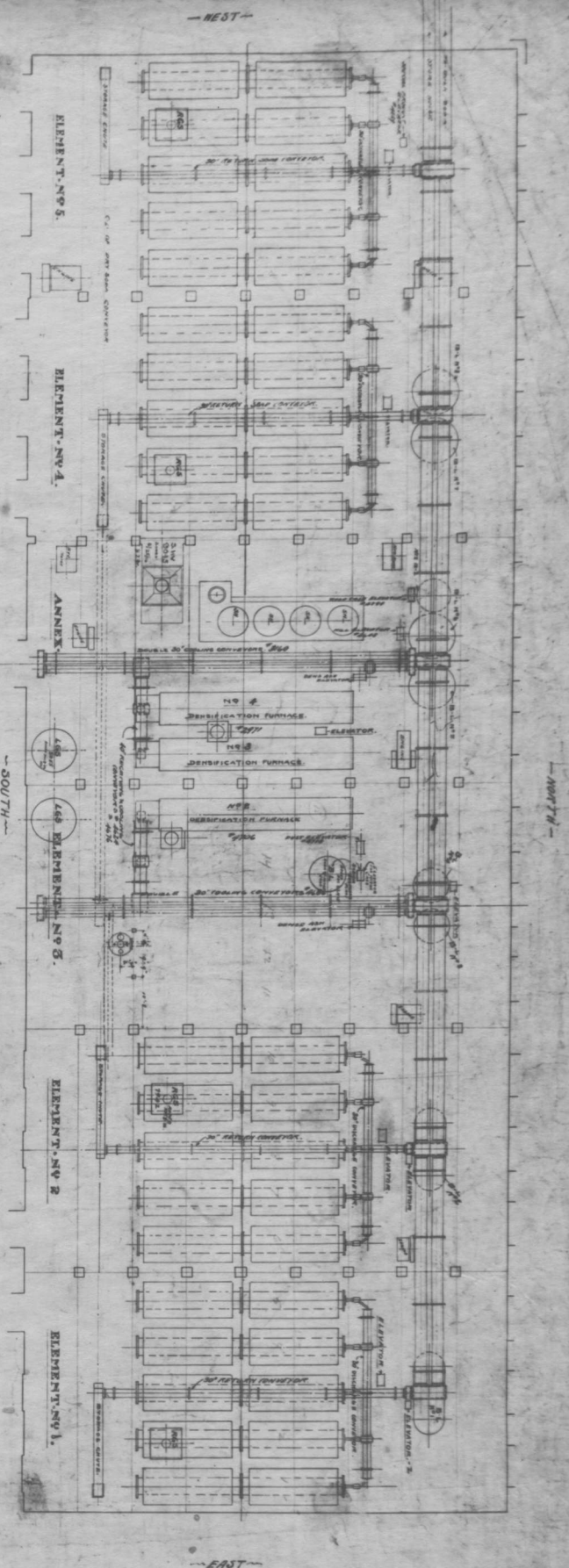
D2402

1/66



CROSS SECTION OF HULL  
 1/4" = 1'-0"  
 1/8" = 1'-0"  
 1/16" = 1'-0"  
 1/32" = 1'-0"  
 1/64" = 1'-0"  
 1/128" = 1'-0"  
 1/256" = 1'-0"  
 1/512" = 1'-0"  
 1/1024" = 1'-0"  
 1/2048" = 1'-0"  
 1/4096" = 1'-0"  
 1/8192" = 1'-0"  
 1/16384" = 1'-0"  
 1/32768" = 1'-0"  
 1/65536" = 1'-0"  
 1/131072" = 1'-0"  
 1/262144" = 1'-0"  
 1/524288" = 1'-0"  
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**GENERAL ARRANGEMENT,  
— OF —  
CONVEYOR SYSTEM.  
IN ELEMENTS.**

THE SOLVAY P.  
JUNE 17. 1896.

DRAWN BY: E.W.M.D.  
CHECKED BY: GNB  
APPROVED BY: GNB

SCATTER  $\frac{1}{16} \approx 1$

100

SCATTER  $\frac{1}{16} \approx 1$

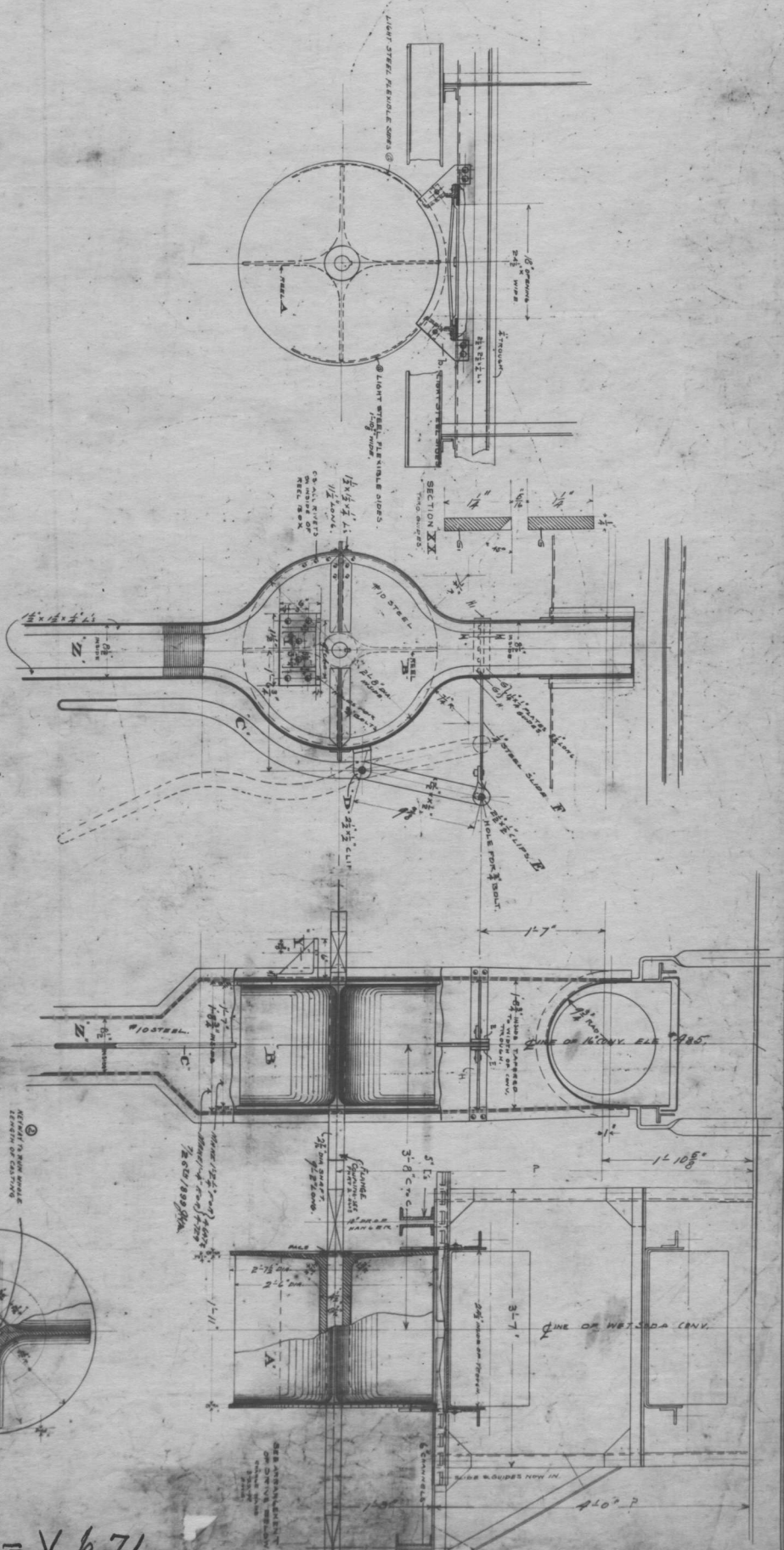
3391

3391 - V. p. 66

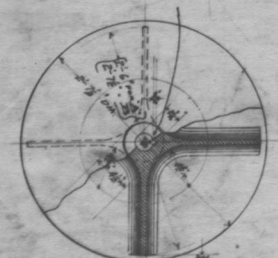






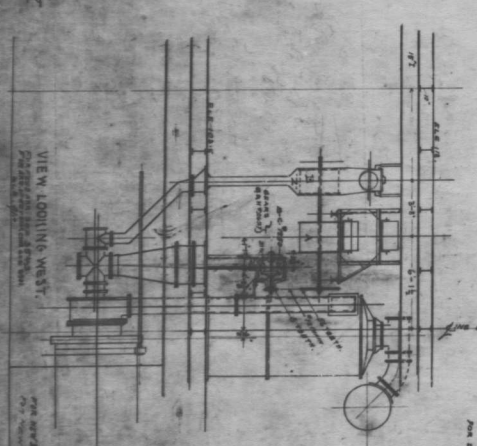
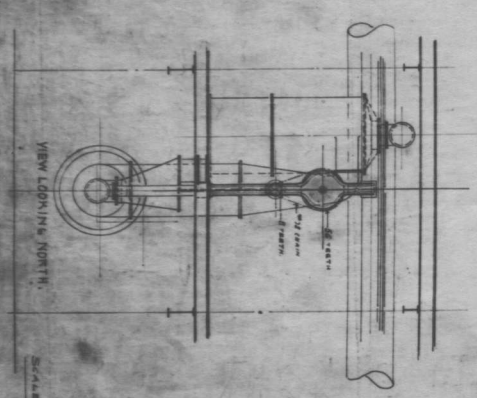


NOTE  
 PATTERN TO BE MADE IN SECTIONS  
 SOUTH IT MAY BE USED FOR BOTH A & B  
 THE DRILLING OF HOLES IN THE PATTERN SHOULD BE DONE  
 IN THE SAME MANNER AS IN THE ORIGINAL DESIGN



C. I. REEL A & B

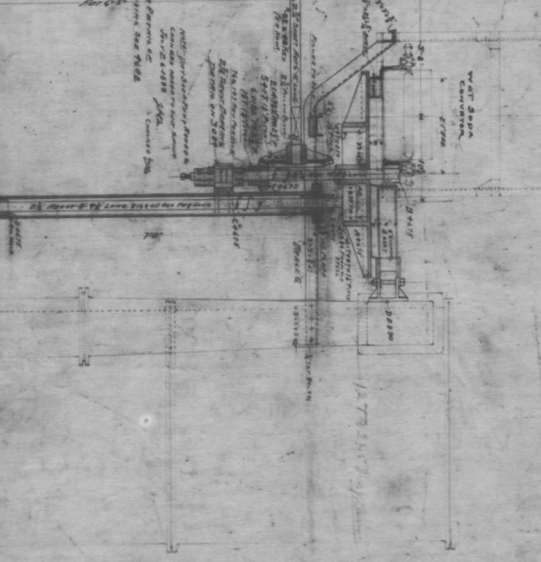
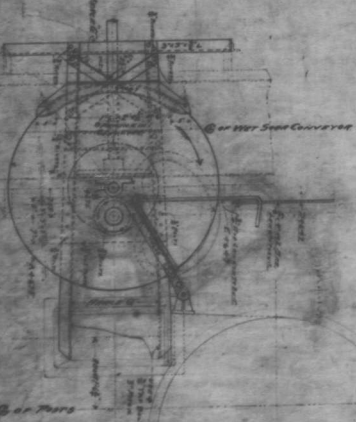
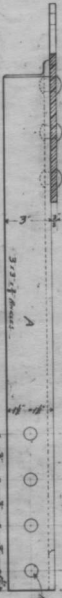
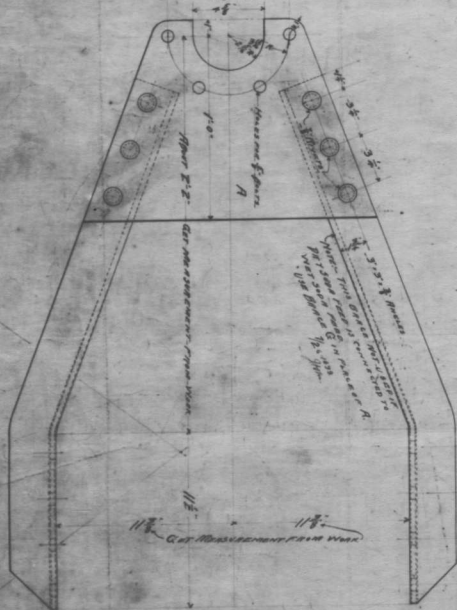
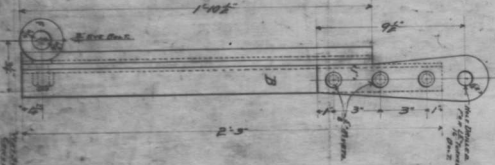
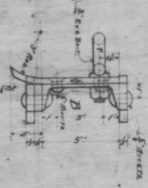
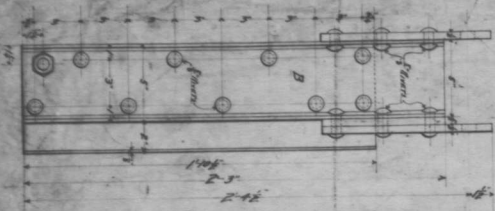
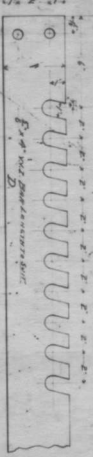
REVISIONS	
NO.	DESCRIPTION
1	As per design
2	As per design
3	As per design
4	As per design
5	As per design



ARRANGEMENT OF C. I. REEL FOR MEASURING GAS  
 THE SOLVAY PROCESS CO. SYRACUSE  
 FEB. 23, 1899  
 DRAWN BY J. H. B.  
 CHECKED BY J. H. B.  
 APPROVED BY J. H. B.  
 SCALE 1/4" = 1'-0"

4608 V. p. 71





Food Measuring Apron

SH7

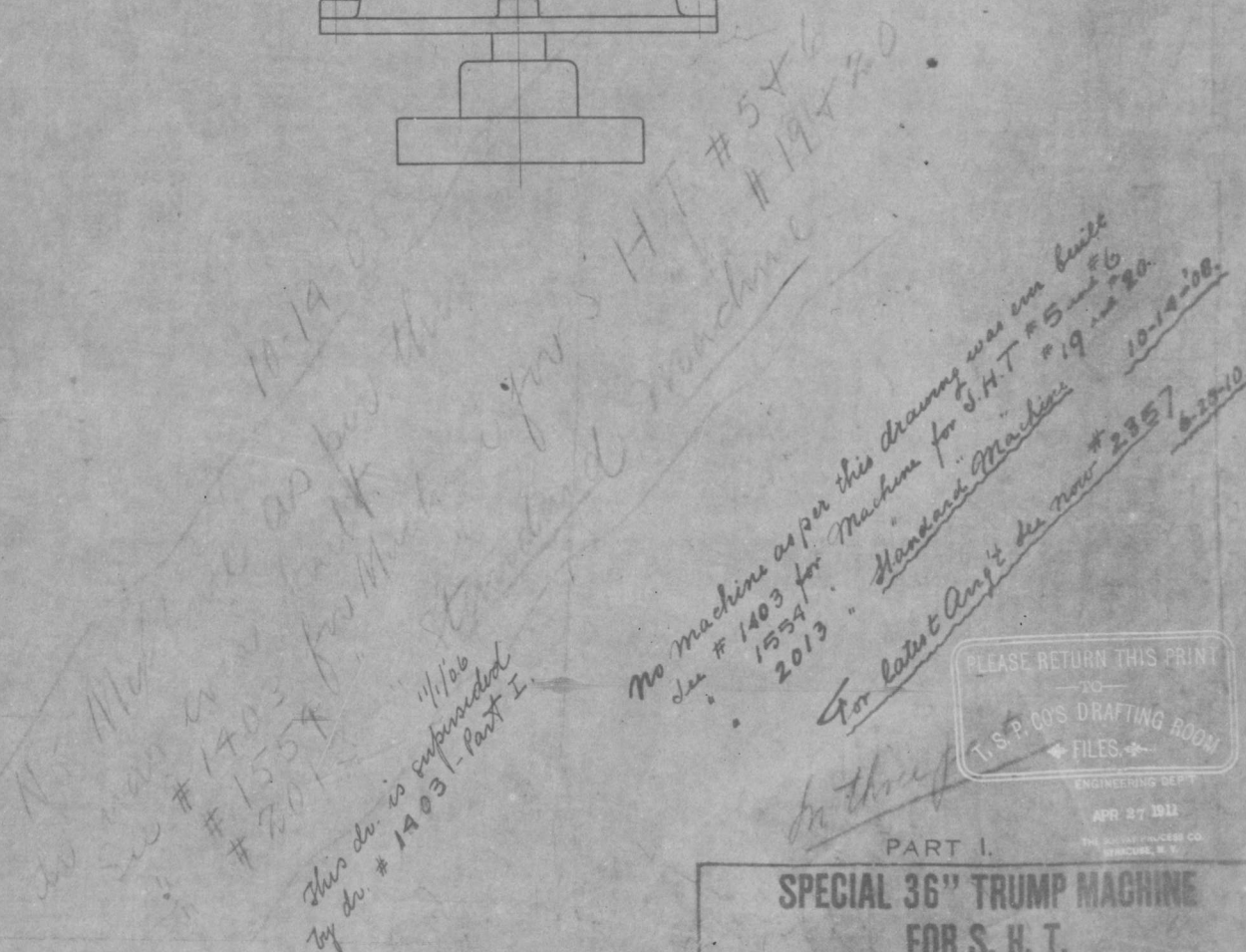
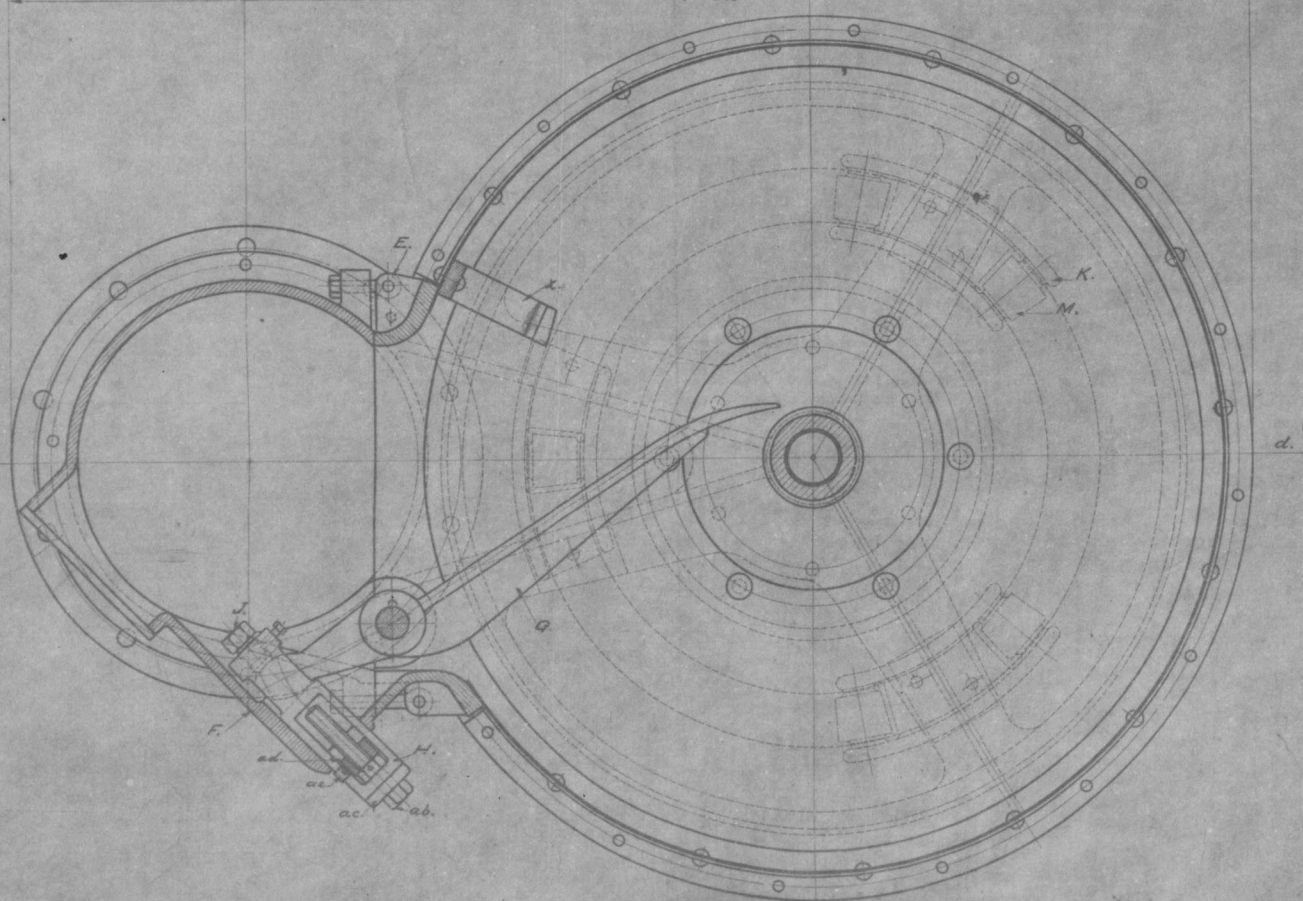
Sealed Air

THE SOLWAY PROCESS

4648  
1/1

4648 = V. p. 71





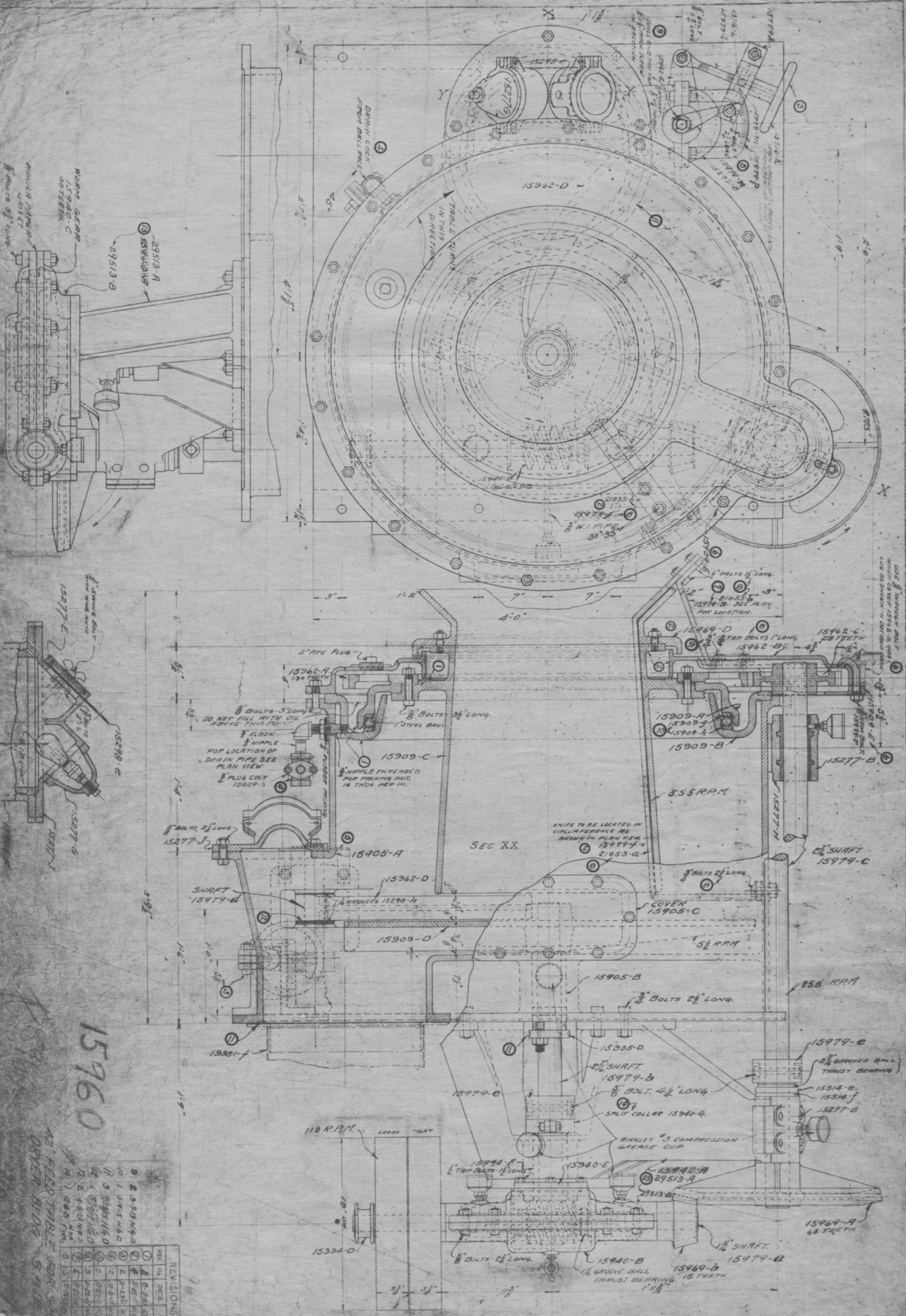
PART I

**SPECIAL 36" TRUMP MACHINE  
FOR S. H. T.**

SCALE 3" = 1'-0"

Drawn by *AAA*      July 20, 1995





15960

43 FEED TABLE FOR S...

DRIVER BLDG 5700

REV.	DATE	BY
1	10/1/50	J. H. B.
2	10/1/50	J. H. B.
3	10/1/50	J. H. B.
4	10/1/50	J. H. B.
5	10/1/50	J. H. B.
6	10/1/50	J. H. B.
7	10/1/50	J. H. B.
8	10/1/50	J. H. B.
9	10/1/50	J. H. B.
10	10/1/50	J. H. B.
11	10/1/50	J. H. B.
12	10/1/50	J. H. B.
13	10/1/50	J. H. B.
14	10/1/50	J. H. B.
15	10/1/50	J. H. B.
16	10/1/50	J. H. B.
17	10/1/50	J. H. B.
18	10/1/50	J. H. B.
19	10/1/50	J. H. B.
20	10/1/50	J. H. B.
21	10/1/50	J. H. B.
22	10/1/50	J. H. B.
23	10/1/50	J. H. B.
24	10/1/50	J. H. B.
25	10/1/50	J. H. B.
26	10/1/50	J. H. B.
27	10/1/50	J. H. B.
28	10/1/50	J. H. B.
29	10/1/50	J. H. B.
30	10/1/50	J. H. B.
31	10/1/50	J. H. B.
32	10/1/50	J. H. B.
33	10/1/50	J. H. B.
34	10/1/50	J. H. B.
35	10/1/50	J. H. B.
36	10/1/50	J. H. B.
37	10/1/50	J. H. B.
38	10/1/50	J. H. B.
39	10/1/50	J. H. B.
40	10/1/50	J. H. B.
41	10/1/50	J. H. B.
42	10/1/50	J. H. B.
43	10/1/50	J. H. B.