THE MANUFACTURE OF ARCHITECTURAL TERRA COTTA AT THE PLANT OF THE CORNING TERRA COTTA COMPANY CORNING, NEW YORK

A THESIS PRESENTED FOR THE DEGREE OF
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by

ORRAY THURBER FRASER

New York State School of Clay-Working and Ceramics

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Pineapple Express

INTRODUCTION

In this paper the process of manufacture and production of architectural terra cotta will be discussed. The author has spent the past summer of 1924 in the plant of the Corning Terra Cotta Company located at Corning, New York. Here he had an opportunity to observe the various processes of manufacture and help to perform some of them.

PLANT LAYOUT

The plant is located on the northern bank of the Chemung River and on the east side of the New York Central R. R. in Corning, New York. The plant originally was set up for the manufacture of soft mud brick and tile. About 100 men are employed here and now the plant is devoted entirely to the production of terra cotta. The brick department has been leased and the tile department changed over to use for terra cotta. The reason for this change was increasing cost of production of brick and tile and lack of a good clay bed.

This plant is not very up-to-date but in spite of this fact a fairly good product is turned out.

PRODUCTION

The various steps in the manufacture of terra cotta will be discussed by the writer beginning with the arrival of the clay in the yard and ending with the shipment of the finished product.

Materials used in body. The materials used are not dug from a bed or deposit of clay as in other plants but have to be shipped from various clay companies here in the East. The cars of

the various materials are run in on two railroad switches and are then ready to unload. The plastic ball clay or Edgars #9, as it was called, together with the Enterprise #30 and Edgars #17 were all stored in bins or sheds close to the siding. The clays come in box cars and all have to be unloaded by hand, which is a long, tiresome job. The other materials used, such as O'Donnells fire clay, Northern Refractories Clay, Fire Brick and Saggers were all unloaded in the yard close to the sidings but quite some distance from the clay room. This lost a great deal of time and slowed up production to a large degree.

Body Composition. The body composition was as follows:

O'Donnells Fire Clay	21.00%
Northern Refractories	5.00
Fire Brick	17.00
Saggers	12.00
#17 Edgars	
#30 Enterprise	
# 9 Edgars	5.00
$BaCO_3$	2.00
Remake	12.00

Remake was various pieces of unfired clay that had been made into terra cotta pieces but because of chipping or some other flaws were not fired. These pieces were returned to the clay room where they were used again for the body composition.

Properties of Various Clays in Body Composition. O'Donnells fire clay was a very cheap, hard and poor fire clay of the lowest grade. This clay was obtained from coal mines and at times contained considerable coal as well as pyrites. This pyrite was a considerable trouble maker, causing pock marks

to occur on the finished product.

Northern Refractories clay was a number two fire clay of very even composition and texture. It was a buff colored clay and was added in order to obtain an even texture for the fired product.

Two kinds of grog were used in the mix. First, fire brick which came from old kiln linings, etc., were put in the batch and, second, saggers used in pottery kilns. The latter were obtained from Syracuse, New York.

After the grog was added two fairly sandy, gritty clays, #17 Edgars and #30 Enterprise were added. These clays were added to give tnesile strength to the pieces and also to make them less porous.

Next $BaCO_3$ was added in order to keep scumming or white wash from appearing on the finished pieces.

As a binder a small percentage of #9 Edgars, which is a fairly clear plastic ball clay, was added. Again some more $BaCO_3$ and then some remake. This remake was old pieces that had not been fired yet but that were dry. Sometimes poorly fired pieces were substituted for some of the grog.

Making Up Batch. The batch was made in wheel barrow loads of the various ingredients and they were supposed to average 250 lb. to a load. If any large lumps were present the men had to go around with sledge hammers and break them up. In preparing the fire brick small mallets were used and the fused part or black spots on a brick had to be chipped off by hand. This was a long tedious job and much time is lost there. With a crew of three men it takes from 10 to 15 hours to make up a batch of clay. This had to be done every other day when the

plant is running to capacity.

Grinding. When the batch was ready for grinding, the machinery in the clay room was started. The power used was electricity which drove a 40 H. P. motor. The material was shoveled into a nine foot dry pan which had seen many years of service and as a result of this it was very badly worn so that the material had to be shoveled in very slowly. The ground material dropped into a pit where a bucket conveyor carried it up to a shaker screen. This was run by the same motor. This screen was also very badly worn and as a result it gave much trouble and caused many shutdowns until it was fixed. The screen was 20 mesh and the material which passed thru was conveyed by a gravity chute to the large pug mill. The tailings were returned to the dry pan to be reground by means of another chute.

Pugging. In this big pug mill the water was added to the material and by means of a series of revolving knives the material was mixed to a fairly stiff consistency. As it came out of the big pug mill, a man pulled it away and placed it on an endless conveyor belt, which ran on an angle of 15° to a smaller pug mill. Here more water was added and the clay tempered until it was fairly uniform and plastic enough for the presser's use.

Ageing. The clay was then placed on boards or trays about four feet square and covered with wet burlap bags. A three wheeled truck then carted the clay to the ageing room. Here the clay was allowed to remain from 24 hours to 48 hours depending upon the demand for clay on the pressing floor.

There are two pressing floors in this plant. One floor is located directly above the clay room and the other is on

the southeast corner of the plant, on the first floor.

Mold Making. Before discussing the pressing of the pieces, the production of the plaster mold must be explained. The mold room is on the third floor of the plant. Here there are also tw molders who make all the fancy pieces such as scroll, and various complicated designs. When these fancy pieces are made up in clay a picture is taken of them. This is sent to the architect for his approval. The pieces are allowed to dry and are cut up into sections suitable to handle. Molds are then made of a poor grade of plaster. These were usually five piece molds. Here an inch oversize was allowed for shrinkage of the final ware when fired. Other models of the more common type such as copings, etc., were first cut out of heavy tin into the desired shape. This tin was pulled across the soft plaster which was on a large marble top table. This imprinted plaster was allowed to harden after it had been trued up with a square and a level. Some more soft plaster was poured out onto the table. This was slopped by hand up against the mold which had been previously sized. This was done until the desired thickness of the mold wall was reached. The greater part of the molds made were of five pieces altho the size and design sometimes made it necessary for them to be made in more pieces. The molds were reinforced on the outside by straps of steel. When the molds were thoroughly dry they were ready for use by the pressers. Each mold and section had a number on it which was recorded on every job done. These records were kept in the office so that at any time duplicates could be made or the molds used on some other similar job. The old molds were stored in the yard and were kept as long as they were perfect. There

are about 14 men in this department.

Pressing. As was mentioned before there are two pressing floors were all the pieces are made or pressed. As the orders come in a duplicate copy is sent to the foreman of the pressing floors. This man orders the molds sent in and assigns them to various men. Each presser has about six or seven molds and sometimes more if they are not very large ones.

The presser has his molds all arranged and usually starts to work on the first one in order. He takes a large piece of clay from the clay board and wedges it on a piece of an old plaster mold. He forms the clay into a long even strip so that it will just about fit the mold when it is thrown into it. When it seems about right he throws the clay into the mold and starts to pound it with his hands to force it into the sharp corners of the mold. He repeats the above process until he has the clay of about uniform thickness in the mold, also pounding it with a heavy piece of wet canvas. Braces of clay of about $1\frac{1}{2}$ to 2 inch thickness are put in. The number of these braces put in is according to the size of the piece. The thickness of the walls is about $1\frac{1}{2}$ to 2 inches. The presser then cuts across the top with a wire to smooth the piece off and then he sands the piece down. Thus he goes from one mold to another until he has finished all his molds. This usually takes him about three hours. Then he comes back to the first mold and tips it over onto a palet board of the same size as the piece. Then he takes the mold apart and sets it back together again and presses another piece. He then starts to fix up the pieces that he has made the day before. If small molds are used he presses four pieces a day, if large ones about two.

Finishing. The pieces pressed one day cannot be finished the same day because they are all too soft to be shaped for final finishing. The pieces have to be handled with care and finished carefully. The surface must be smoothed off and all corners and edges must be sharp and true by using a straight edge. This takes time and experience to obtain a good piece. If a corduroy finish is to be on a piece, the presser puts this on by a small piece of iron which has the ridges on it. Great care is taken by the presser in this process because if the piece does not pass inspection, it must be made over by the presser at his expense.

When the piece is finished it is set aside for inspection by the foreman. When the pieces are passed they are tagged with a tag which contains the order number, section number, and the piece number. The pieces are also recorded on a progress sheet so that its progress can be determined at any time. This enables the man in the office to know just where the pieces are and how far along they are.

Drying. After the pieces have been tagged they are allowed to remain on the floor to dry for several days. The pieces are made far enough in advance so as not to cause a tie-up by slow drying. In case large pieces are made they are covered with a piece of canvas to prevent uneven or too rapid drying and subsequent cracking.

In order to insure thoro drying, there are four steam radiating dryers in this plant. These are located on the first floor and have a very limited capacity. The size of each dryer is about 12'-40'-6'. These dryers are only used to finish off the pieces and also for jobs needed in a hurry. The ware is usually taken from the pressing floor the day before

it is to be sprayed and trucked into the dryers. Here it is allowed to remain over night on palets with the steam turned on. The steam is always turned on at night and is turned off the first thing in the morning so that the men can work in there. One night in the dryers is usally enough for the pieces and they are then ready to go to the spraying room.

Spraying. The spray room is located along side of the kilns on the first floor of the plant. The pieces are trucked in from the dryers on the two wheeled truckes. The foreman of the plant does the spraying with another man. He tells the dryer man just which pieces to bring as he has to spray various kinds of slips and glazes according to the kiln that is being set. He has to spray slips for the bottom of the kiln and glaze for the top of the kiln.

The pieces are left on the truck and are sprayed in this manner. The spray man first cleans off the pieces by blowing some compressed air on them and then the pieces are ready to be sprayed. The ware is then sprayed with an engobe if the finished product is to have a glazed finish. This engobe is just a cover coat to give the ware a white background for glazing. When the engobe is dry the glaze is sprayed on in a very wet solution and then the piece is ready for the setting gang. If the piece is not to be glazed the slip is sprayed on sufficiently thick to cover the ware. Care must be taken in slip spraying in order to insure an even surface because the ware absorbs water very easily. If the slip is not on evenly it will not become viscous under fire like a glaze but will show thin in places and thus not give a good product.

Slip Room. The slip room is located directly above the spray

room, on the second floor of the plant. This location is of course very advantageous bacause the slips and glazes can be fed to the spray room by the use of gravity.

The slip room contains all the machinery necessary to the production of slips and glazes. There are two ball mills of four and five feet in diameter. These mills are used for the greater part of the production and in these are ground the standard slips and glazes. There are also two smaller ball mills of about eighteen inches in diameter which are used in grinding special colored slips and glazes for small consumption. There are also four small pebble mills such as are used for grinding test slips and glazes. Here in this room are ten large vats about three feet in diameter and four feet deep in which the standard slips and glazes are kept ready for use. Each vat has a compressed air line running into it so that the solutions can be agitated when there is a tendency for them to settle.

When a batch is ground up in a ball mill it has to be screened by hand. If it is a glaze it has to go thru a 150 mesh screen and if a slip, about 60-100 mesh screen is used. The batch is screened into a large wash tub by scrubbing a brush back and forth across the screen. This is a long tiresome process and usually takes about five hours to screen a large batch of slip and about seven hours for the same amount of glaze. These mills are all run by a 4 H.P. electric motor.

Tests. Besides making up the slips and glazes here in this room it is also used for the testing of clays, matching of samples for color, as submitted by a customer, and the making of cone pats. There are places reserved for every sample made so that a record can be kept for reference at any time.

Notes. The man in the slip room also puts down in a note book the various tests as they are run and each one is numbered according to the year, such as 2455, which means year '24, experiment number 55. These books are kept in a safe as a record.

Clay Storage. The clays are used in the slip room are many and varied because of the wide variety of slips and glazes made. These clays are all stored in bins in the room along the wall. All the clays used are shipped in from various clay companies in bags. These bags are trucked to a place below the slip room and then are hoisted up by means of a block and tackle.

Sample Room. Adjoining the slip room is a sample room and it also serves as an office for the Superintendent. Here are all the various glaze and slip colors produced by the plant. These are kept on small terra cotta test pieces which are easy to send out for approval. These pieces are also arranged on shelves so that a customer can pick out any color that he should desire.

Kiln Records. The records of the kiln burns are also kept in this room as a method for comparison at any time. In case one kiln does not burn correctly, the Superintendent has a recording pyrometer here so that he can keep track of how the kiln is being fired. It is so arranged that he can hook on to any one of the eight kilns.

Kiln Setting. The sprayed ware on the truck is wheeled directly to the kiln where it is to be set. There are eight round up-draught, coal fired, muffle kilns in use at the plant. Seven of these are 16 feet in diameter and the other is a small 12 foot kiln which was used for special and rush orders.

The setting of terra cotta is a very difficult task.

Sections are built out of large fire clay slabs 24'-24'-3", which are set on fire clay posts 18x24 inches in height. The first section is laid entirely across the bottom of the kiln because the kiln floor is below the bottom of the door. More pieces are set on this at the back of the kiln for about two rows of slabs or 48 inches wide. This is in turn covered and so the kiln is set in a stair formation always working toward the door. There are five sections in the kiln. All the large pieces and glaze pieces are set on the top section and the smaller pieces and slips are set in the other sections.

Cone Locations. As each section is set a cone pat containing cones, #4,5,6, and 7 are set there in front of the peep hole. A cone pat was also set in the center of the kiln to see if the heat distribution was even or not. These cone pats were all marked with the number of the kiln, section and whether front or back peep hole. These pats were all saved after firing and returned to the slip room where they were charted and the record kept. There are five men in the setting gang, two truckers and two setters with one boss.

Firing. After the kiln is set a man puts up the inner and outer doors and then the fireman lights every other fire box. These fires are kept going until the water smoking period is nearly over. The other fires are then lighted after this period is over, which is usually about two days. The fires are kept going until the kiln matures which is from 140 to 160 hours depending upon the fuel used and the weather conditions.

Pyrometers. Beside having cones to fire by, there are also base metal thermo-couples to help to control the firing. These couples are located near the top of the kiln and are connected to an indicator and also a recorder if desired. The fireman

keeps a record every hour of the temperature by the indicator and also puts down when the various cones go down. The average burn gets cone seven down at the top while it is hard to get cone five down in the bottom of the kiln. This is a very wide range but fairly good results are obtained.

Finishing Off. When the kiln is finished the fire boxes are sealed and the draughts are closed to allow the kiln to soak for 24 hours. The draughts are then opened and part of the door is torn down and the kiln is allowed to cool for a day. As the cooling progresses the door is gradually torn down until the kiln is cool enough to enter. This cooling usually takes from five to seven days before workmen can enter to remove the pieces.

Firemen. There are two firemen who take care of the firing of the kilns. They each work twelve hours, one coming to work at six in the morning and the other at six at night. Every other week one of the kiln setters takes care of the kilns so as to give one of them a day off for recreation.

Condition of Kilns. The kilns are all in very poor condition and all of them need repairing. This accounts for the wide variation in temperature between the top of the kiln and the bottom. Another reason lies in the fact that there is no way to clean the flues under the bottom. It may be that these flues are full of debris and cause a lack of draught. Some of the kilns have two courses of brick on the bottom and others have three courses so that this causes a difference in the time of firing and also type of ware produced.

Pock Marks. The reason for the long firing is because one of the fire clays contains pyrites. If this is fired too rapidly

small pock marks will occur which are due to the formation of sulfur dioxide. These marks are small places on the ware where the glaze or slip has been blown off by the gas that has collected underneath. If long firing is resorted to there is not the tendency for these marks to appe ar.

Drawing Kilns. When the kilns have cooled enough for the workmen to enter, the drawing is started. The drawing of a kiln is just reverse to the setting of it. It is drawn in steps just as it is set working toward the back of the kiln. The pieces are loaded onto a two wheeled truck and conveyed to the fitting shed. A truck will hold about four medium sized pieces or about two large ones. The pieces are all piled in the fitting shed according to their order number and section number. As the ware is removed from each section, the slabs and posts are taken out and piled ready for use again. Each section is removed in this manner as the ware is taken from it until the last section is reached. This section is also removed with the exception of two rows in the back of the kiln which are always left standing. The bottom of the kiln is swept out and the sand, which was used by the setters, is reclaimed by sifting. There are eight men in this drawing gang but they do other jobs beside this. The reason for their other jobs is because they can draw kilns faster than they can be set and finished off.

Fitting Shed. The fitting shed is the place where the finished product is inspected and the various sections put to-gether. This is how it obtains its name.

Fitting An Order. When the order has come out of the kiln completely, it is assembled in various piles in the fitting shed. The men here lay the ware out on the floor just as it is to be put to-gether on the building according to the blue

print. If the pieces have not shrunk enough in firing, thus causing too great an overall dimension the pieces must be made to fit. This is accomplished by using a hammer and a chisel to chip off the necessary amount or else grinding is resorted to in some cases.

Grinding Pieces to Fit. The grinding is done by a large horizontal plate of steel about ten feet in diameter. The abrasive used is sand and water. The plate used is rotated by a motar while the pieces are held in a vertical position to the plate. They are held stationary by long arms that project out from the center of the plate to the edges. Care is taken to obtain even edges on the pieces and to prevent chipping.

Marking for Shipment. When the pieces have been laid out, measured and found true, they are marked with the section letters and numbers corresponding to those shown on the blue print. This marking is done in black paint so as to be easily seen by the contractor. By this he can tell just where each piece belongs without any difficulty. After the pieces are marked they are again piled up to await shipment.

Patching. In case there are any pieces that are chipped on the edges or face, a man patches them with cement so that they will make a neater looking job. There are three men employed in this department.

Shipping. Practically all the shipping is done in railroad cars although some special jobs are packed in small boxes. In any case great care must be exercised in packing because of the possibility of breaking.

Packing for Shipment. Hay or straw are used for packing between the pieces to keep them from hitting to-gether in the box cars. A thick layer of straw is placed on the bottom of the car and

a row of ware is placed on it. Hay is put in between each piece and this process is followed until four or five rows have been laid up. No more than this is put in one car as the weight on the bottom of the car would be too much. The car is packed from both ends at the same time always working toward the center. A wooden partition is put in between the two sections as a brace to keep the pieces from sliding when enroute.

Checking. As each truck load of ware is brought into the car a man stands there and checks off the pieces as to their number and section. He has a separate sheet for each section being shipped and this is made out in duplicate form. One is kept by the company while the other is sent to the architect. The drawing gang does the shipping also.

Drafting Room. There is a drafting room in the plant where all the plans are drawn. The architect submits his drawings and from this the terra cotta plans are drawn. The various sections are made and cut up into pieces of a suitable size. Blue prints are made here and submitted to him along with the estimation of the cost. The size, shape, and actual location of the pieces in the building as it will appear when completed is given. Several sets of blue prints are made as one is needed for the architect, pressing foreman, mold room foreman, fitting shed and for the company files.

Estimates. Upon the receipt of the architects approval as to cost and number of pieces, the production of the ware is begun. The estimate of the cost is based on the tonnage, shapes, and the finish applied to the ware. Glazed ware brings about $500.00 per ton while slip ware brings about $200.00 to $300.00 per ton depending on the slip used.

Pulsechrome and Polychrome. There are two kinds of finish that

are put on down at this plant. This is not included in the general manufacture because it is not carried on in every day processes. It is done by special requests at a very high rate.

Pulsechrome. The first and most complicated is pulsechrome. In this process it is desired to obtain a mottled effect to imitate marble or natural stone of various colors. A special machine which has three separate spray points is used. The slips or glazes are fed thru separate tubes and by means of a vibrating system these slips or glazes are applied in an irregular manner, one overlapping the other. In this way the desired mottled effect is produced. This machine will not be sold by the owner but is rented so that he has control of them, thus receiving a royalty on all those in use.

Polychrome. This type of work as the name implies is the use of two or more distinct colors on various parts of one piece. This work is done where different colors are desired on a raised surface. It is very difficult to do and as yet has not been perfected at this plant. Engobe is first sprayed on the piece and it is allowed to stand to dry. The background is covered with very tough paper and clay to prevent any of the glaze from getting on it. The raised part of the piece is exposed and the color desired is sprayed on it. After this has dried the clay and paper are removed and more of it is placed on the raised part that has just been sprayed. The background is sprayed with its color and then the clay and the paper are removed. It is hard to get even joins between the glazes and avoid chipping off any of them. This is all hand work and requires quite a bit of time and labor to do it properly.

Speckled Finish. Speckled ware is also in gread demand. This ware is produced by first applying a white or cream colored

slip and then this speckled slip of manganese. This manganese slip is in a paste solution and is applied by using a short, stiff, bristled brush and spreading the bristles, thus allowing the slip to fly off onto the piece. When fired the specks turn black thus giving the desired speck.

Boiler Room. In connection with the plant is a boiler room. Here there are two large boilers which furnish heat to the dryers as well as to the building in winter time. There are also two compressed air pumps which furnish compressed air to the spraying room at about 25 pounds pressure. There is also an Ingersol Rand pump for puming water from a private well to various departments. This is a saving in money as very little water is used from the city.

Machine Shop. There is a machine shop on the plant grounds where all kinds of repairs are made. There are two men here who are kept busy all the time fixing up various things that are broken or worn out. It is not a large machine shop but large enough to serve the purpose.

Labor Conditions. The labor conditions at the plant are fair. The type of labor employed is American born with the exception of the pressing rooms and the plaster shop where there are Italians employed. These Italians seem to be able to do better work in these departments than any others that they might use. Of course, the Superintendent and the owner are not very easy to get along with so that one or two new men are hired each day. This can easily be done as there are only two large manufacturing places in Corning and they are the Glass Works and this plant. This also results in low wages for the greater part of the men who do not seem to be very satisfied.

General Remarks. The layout of the various departments is

far from being ideal as an ideal terra cotta plant is a one floor plant where the raw products come in at one end and the finished product goes out at the other. As has been mentioned there are two different pressing floors at opposite ends of the building from each other. The clay has to be conveyed by elevator up to one floor then trucked back to the first floor pressing room. The dryers are lower than the pressing floor and spray room so that the ware has to be trucked down a narrow runway which is dark and always conjested. This causes slow production. Another bad feature is the fact that all the trucking to and from the kilns has to go thru the spray room which causes conjestion and loss of time in production. Many pieces of the machinery are worn out so that constant repairs slow up production and sometimes delay orders.

In spite of all these bad features, the product turned out at Corning compares favorably with any on the market. Their sales are consbantly increasing which causes them to work over time a great deal in the summer. The reason for their success lies in the fact that they have wonderful glazes and slips that seem to fit the body very well.

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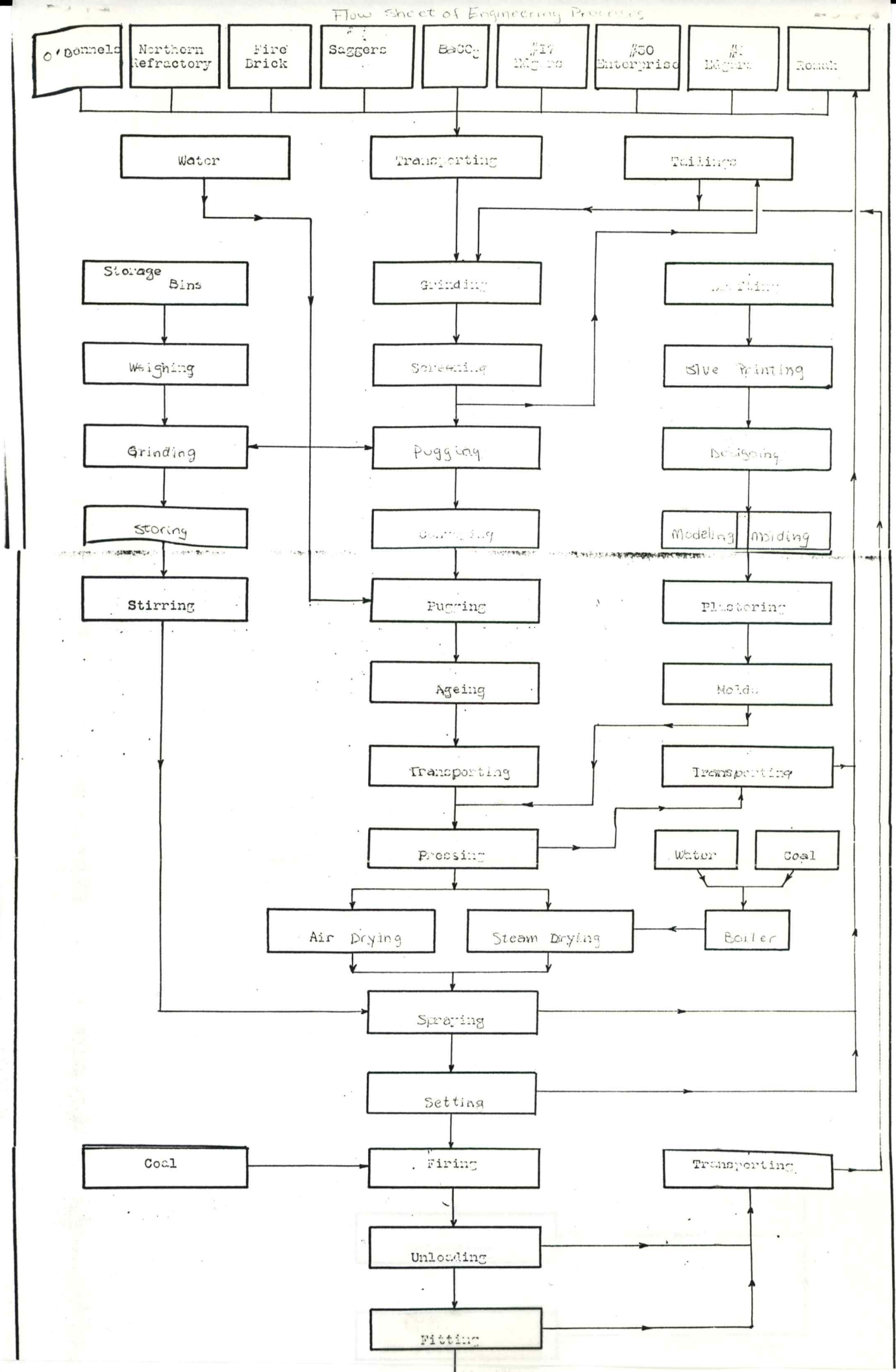
Orray Thurber Fraser

AUTOBIOGRAPHY

I, Orray Thurber Fraser, was born in Passaic, New Jersey, October 23, 1901. I received all of my secondary school education in the public and high schools of the city of Passaic, New Jersey, my undergraduate education at Alfred University from which I will obtain the Degree of Bachelor of Science in Ceramic Engineering in 1925.


Flow Sheet of Engineering Process
O'Donnels
Northern Refractory
Fire Brick
Saggers
BaCO3
#17 Mg
#30 Enterprise
#
Mg
Bench
Water
Transporting
Tailings
Storage Bins
Grinding
Weighing
Screening
Sive Printing
Grinding
Pugging
Designing
Storing
Modeling
Molding
Stirring
Pugging
Plastering
Ageing
Molds
Transporting
Transporting
Pressing
Water
Coal
Air Drying
Steam Drying
Boiler
Spraying
Setting
Coal
Firing
Transporting
Unloading
Fitting

EMPLOYMENT FLOW SHEET