1935

A study in the production of calendered linoleum

Harry Simanton Pence

Department:

A STUDY IN THE PRODUCTION OF CALENDERED LINOLEUM

by

H. S. Pence

A

T H E S I S

submitted to the faculty of the

SCHOOL OF MINES AND METALLURGY

of the

UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

D E G R E E O F

ENGINEER OF MINES

Rolla, Missouri

1935

Approved by J. W. Steinmetz
Professor of Mining

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LIST OF ILLUSTRATIONS

Note:- All plans are purely diagrammatic, as the actual detail construction plans were not allowed to be taken from the engineering office.

FOREWORD

The Certain-teed Products Corporation were originally roofing manufacturers. The company was founded, about 1908, by George M. Brown, around the old General Roofing Company of East St. Louis, Illinois. As such, this company enjoyed a good business and gradually enlarged its roofing capacity and expanded into allied building lines. By 1920, it was well established in roofings, building papers and paint and varnish.

In the wild avalanche of building contracts in the early 1920s, the organization found its plant capacities inadequate and its cash balances very large. The vast linoleum and oil cloth plant in Philadelphia was acquired from the Potter estate in 1923. In 1924, the American Cement Plaster Company was purchased from Mr. Sam Lazarus of St. Louis, Missouri, and in 1925, the George R. Cooke linoleum plant in Trenton, New Jersey. Then followed those lush harvest years for the building lines. Therefore, in 1928, with little reckoning of the future, Certainteed assumed the outstanding indebtedness and bond issue of the Beaver Products Corporation, thus nearly doubling the number of plants and plant capacity.

The properties and plants acquired during this phenominal twenty-year growth had been poorly

maintained, and the equipment was obsolete in many cases. Also, the effect of the old-style managers, who went with the inventories, was never entirely lost. True, the Certain-teed Products Corporation bought into the game by each purchase and erased a competitor, but it paid dearly in obsolescence, high appraisals and inventories.

In January of 1925, the writer went with the Certain-teed as engineer for the mining properties of the plaster division. The planning needed for such far-flung properties, making such diversified lines, was enormous, and far greater than the two-man engineering staff could assimilate. So it was in chemical research. Trained technicians and managers were not available. Demands for new equipment and methods sent the writer through the plaster and paint and varnish divisions, and finally to the Trenton, New Jersey, plant of the linoleum division.

A staff was gradually built up capable of handling the problems of a plant having ninety-three buildings and extending over thirty-five acres of ground space.

The yearly value of the products at Trenton was in excess of five million dollars in 1926 and 1927, but gradually declined to about two and a quarter million in 1930. Intense competition by the three large competitors (each capable of producing 30 to 50 per cent of the country's needs) was responsible for some part of the

diminishing sales. But the greater loss was due to the lack of new and fresh patterns and to the worn out and high-cost equipment in use. Also, to complicate problems, the growth of the old plant had been so poorly planned that the buildings would not accommodate newer machinery. Nor had there been adequate provision for financial reserves to provide such large-scale revision.

The problems given first attention were those in which the ratio of return to the investment was greatest. Most of these were purely maintenance problems or those caused by poor supervision of the department heads. Soon, appreciable savings were shown by decreasing idle machine time and the quantity of imperfect or "off goods."

Other problems involving power and heat, packing and shipping, lighting, inspection and inspection standards, insurance, taxes and safety were undertaken, as well as those purely mechanical in nature.

At the same time, research into formulae and plant procedure was attacked jointly by the engineering and chemical staffs. One such problem, E-177, is presented as typical of that work. This represents purely the engineering study and soes not attempt any digression into the realm of chemistry. The report of the chemists accompanied this report in its original form.

The report which follows, though lacking in many respects, was the general style in use by the com-

pany at the time. In general, an investigation was divided into two parts, (1) the recapitulation with its recommendation and (2) the detailed discussion and engineering addenda with its plans and calculations entered on bound scratch books. The latter never left the engineering department--this detailed discussion went to the plant superintendent, plant manager, division manager and vice-president in charge of manufacturing, all of whom initialed it along the route. Any dissenter would return it for further work or classification. The recap, itself, also thoroughly initialed, went to the president and board of directors for approval and appropriation of funds. This system seemed quite workable, as detailed work did not serve to confuse the board of directors or others not concerned with it.

The actual research into this problem was started in 1928 and occupied a full two years. Because of the length of time consumed in process from raw material to finished product (five to six months with the old formula and two to three months with the Wood and Bedford Formula) the work was considerably complicated. It was necessary to entirely bracket the various batch formulae with all their plausible combinations, rather than wait the two to three months for confirmation of the finished product.

Equipment of commercial size had to be designed and installed, because the results from labora-

tory-size equipment was found very misleading.

Shipments of finished goods in their standard-size rolls and crating were shipped to points throughout the United States, and then returned to us for observation of their shipping qualities. Other finished-product tests included weering, acid, heat, light, fading, bending, and warehousing under below-zero conditions.

It has not been possible to secure the entire folio of plans and prints that originally accompanied this report. The total engineering addenda is lacking, as it was not permitted outside of the plant engineering files.

Mr. H. M. Van Horn was in charge of the chemical research, with Messrs. McGee, Benson and Noller as assistants. The writer was in charge of the entire problem, with Messrs. Halliday, Unwin, Conti, and Newman as assistants.

The operating departments under Messrs. Wilkie, Hall and Dahlgren gave most excellent help and many worthy suggestions.

Messrs. L. A. Pockman and C. W. Brown, plant and division managers respectively, gave excellent support and encouragement, as well as appropriations for the work.

REPORT

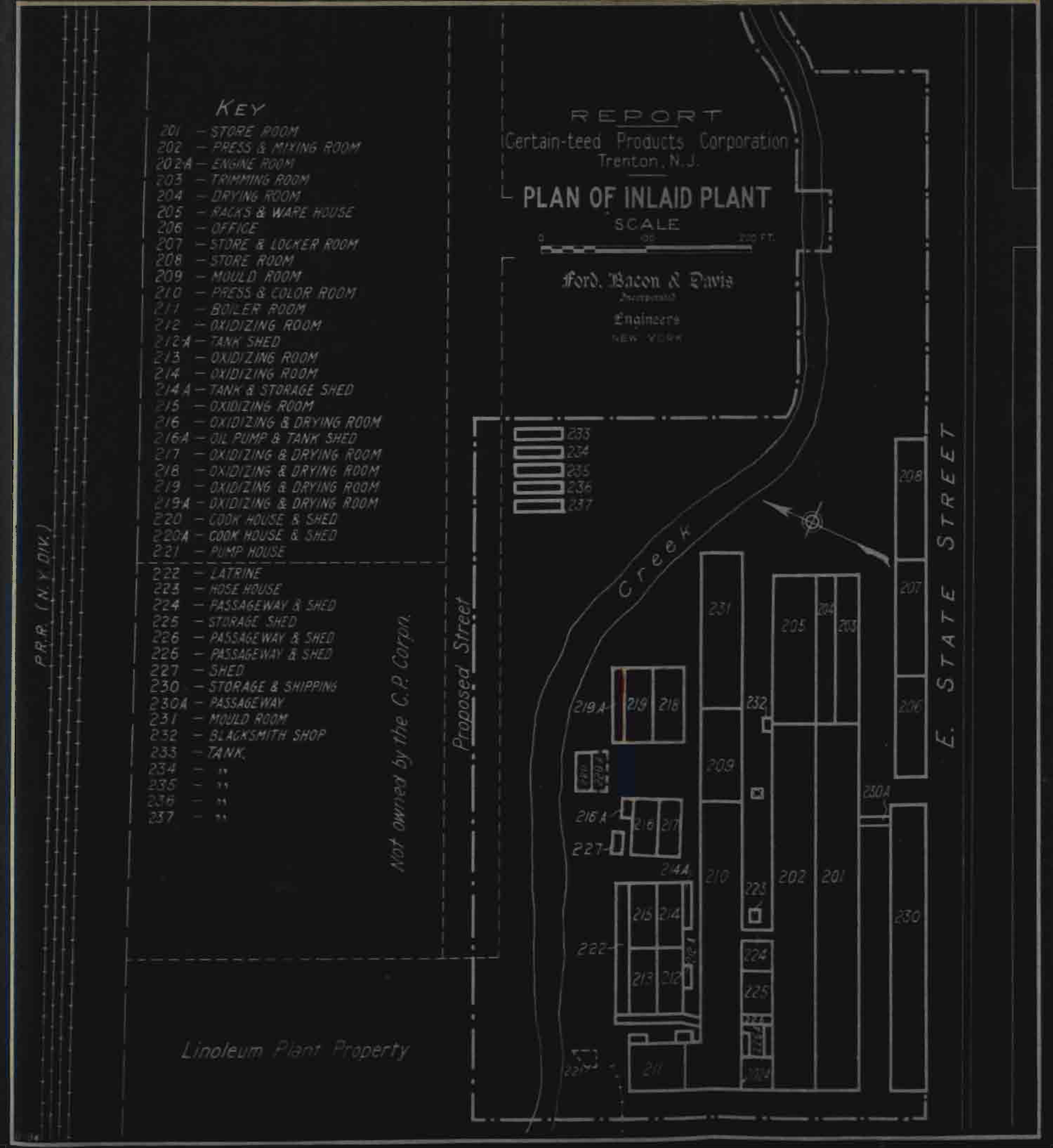
Certain-teed Products Corporation
Trenton, N.J.

PLAN OF LINOLEUM PLANT

SCALE
0 100 200 FT.

Ford, Bacon & Davis
Incorporated
Engineers
NEW YORK

U-194


KEY
201 – STORE ROOM
202 – PRESS & MIXING ROOM
202A – ENGINE ROOM
203 – TRIMMING ROOM
204 – DRYING ROOM
205 – RACKS & WARE HOUSE
206 – OFFICE
207 – STORE & LOCKER ROOM
208 – STORE ROOM
209 – MOULD ROOM
210 – PRESS & COLOR ROOM
211 – BOILER ROOM
212 – OXIDIZING ROOM
212A – TANK SHED
213 – OXIDIZING ROOM
214 – OXIDIZING ROOM
214A – TANK & STORAGE SHED
215 – OXIDIZING ROOM
216 – OXIDIZING & DRYING ROOM
216A – OIL PUMP & TANK SHED
217 – OXIDIZING & DRYING ROOM
218 – OXIDIZING & DRYING ROOM
219 – OXIDIZING & DRYING ROOM
219A – OXIDIZING & DRYING ROOM
220 – COOK HOUSE & SHED
220A – COOK HOUSE & SHED
221 – PUMP HOUSE
222 – LATRINE
223 – HOSE HOUSE
224 – PASSAGEWAY & SHED
225 – STORAGE SHED
226 – PASSAGEWAY & SHED
226 – PASSAGEWAY & SHED
227 – SHED
230 – STORAGE & SHIPPING
230A – PASSAGEWAY
231 – MOULD ROOM
232 – BLACKSMITH SHOP
233 – TANK
234 – "
235 – "
236 – "
237 – "
P.R.R. (N.Y. DIV.)
Not owned by the C.P. Corpn.
Proposed Street
Linoleum Plant Property
REPORT
Certain-teed Products Corporation
Trenton, N.J.
PLAN OF INLAID PLANT
SCALE
0 100 200 FT.
Ford, Bacon & Davis
Incorporated
Engineers
NEW YORK
Creek
E. STATE STREET

E-177

A STUDY OF THE PRODUCTION OF CALENDERED LINOLEUM AT THE TRENTON PLANT OF THE CERTAIN-TEED PRODUCTS CORPORATION OF NEW YORK

SUBMITTED TO THE PRESIDENT OF CERTAIN-TEED PRODUCTS CORPORATION, FEBRUARY 28, 1930, THROUGH CHANNELS

By H. S. Pence

R E S E A R C H R E P O R T

TITLE

Consolidation of Philadelphia and Trenton Calendered Goods Production at Trenton; Revision of the Bedford Oil and Cement Departments to Produce 77 Per Cent Litharge Bedford Cement and Revision of the Body Mixing Equipment

OBJECT

To Determine the Most Economical Plan for Producing All Calendered Goods at Trenton and the Savings Which Might be Expected Through the Use of Wood and Bedford Cement and a Body Mixing System Which Will Produce a More Uniformly Mixed Composition than at Present

INTRODUCTION:

The manufacture of similar products in two different plants results in duplication of effort, high production costs and difficulty in maintaining uniformity. The bringing of Philadelphia production of Battleship, Jaspe and Cork Carpet to the Trenton Plant will enable all calendered goods to be produced under single control, thus insuring uniformity and better supervision. With the decrease in drying time, possible through the use of 77 % Litharge Bedford Cement, there will be available heater space at Trenton to produce all of the 1930 Standard production of both plants, including Battleship, Jaspe, Cork Carpet and Commons.

The Battleship body mixing system is arranged essentially the same as when originally installed. Experience has shown that the equipment now used does not produce a uniform body mix. Furthermore, the production and cost records show maintenance and labor charges to be exceptionally high. It is proposed to resort to more modern equipment to overcome these objections. The possibility of using a Banbury Mixer to meet the demand for more uniform mixing, at low cost, has been investigated in view of the fact that rubber manufacturers, and at least one linoleum competitor, are now using this equipment.

It has been recommended that the Scrim Oil constituent of Walton Cement used in the manufacture of

Battleship and Inlaid linoleum be replaced with Bedford Oil; this Bedford Oil to be made according to the Wood and Bedford formula with which our company has been experimenting the last two years. There are three types of Litharge Bedford Cement--those containing 16%, 38.5% or 77% Wood and Bedford Oil. The first is the cement made with the same formula as the present Walton Cement, but replacing the present type Bedford Oil with that known as Wood and Bedford Oil; 38.5% Cement results when 50% of the Scrim constituent is also replaced by the new Bedford Oil and the 77% Cement contains no Scrim. Since the greatest savings will result when Scrim is totally eliminated, the proposed plan is on this basis.

Throughout this report, the terms Bedford and Cement will refer to the new departments in general producing Wood and Bedford Oil and 77% Litharge Cement, respectively.

GENERAL:

Through the courtesy of the Paratex Corporation, it has been possible to use a #3 Banbury Mixer for experimental production of Battleship composition. Considerable information regarding capacity, construction, etc., has been obtained from the Farrel-Birmingham Company, makers of this equipment. Other information has been obtained from rubber plants using this type mixer.

The Farrel-Birmingham Company recommends without reservation a Banbury Mixer of the proper capacity as being the equipment to meet our mixing requirements. This opinion is based upon the successful operation of a battery of three #9 and three #11 Banbury Mixers, which have been installed at a competitor's plant for more than a year.

Banbury Mixers are unanimously recommended by concerns using them because of reduced labor and maintenance as compared to other equipment for similar work.

It is proposed to install large-sized Bedford Kettles as recommended by the Wood and Bedford people. Considerable information has been gained from an experimental unit installed a few months ago which is almost identical with the installation as recommended for the scrim elimination program. The most economical batches, power and labor requirements have been carefully obtained.

RESULTS:

Experimental calender runs with Banbury mixed composition have shown:

1.- A more intimately mixed composition than is possible with the present equipment.

2.- A surface superior in finish and smoothness.

3.- More uniform curing.

4.- The Banbury Mixer to be equally efficient on all types of Cement.

From the experimental runs, it appears entirely possible that very attractive savings may be effected through decreased formula costs, but this can only be accomplished through a long period of adjustment after the installation of a Banbury Mixer.

Experimental calender runs of Battleship composition made with 77% Litharge Bedford Cement have shown:

1.- A more uniform composition.

2.- An average decrease in curing time of approximately 35%.

3.- Curing to be more uniform throughout the cross-section, thus eliminating past difficulties of wet streaks and skin cures.

4.- That there is no sacrifice of pliability, stiffness, density, surface or life of goods in stock.

In addition to these advantages obtained on calendered goods, 77% Litharge Bedford Cement produces less yellowing, as well as brighter and deeper colors in Inlaid composition.

PLAN OF ARRANGEMENT - BODY MIXING:

The installation of a #11 Banbury Mixer will replace all the mixing equipment used in Common Body

Mixing and everything except the scratcher for Battleship and Plain Body Mixing. It will be installed in 2-C building, and the height of the machine works in well with the beam spacing. The machine bed-plate will rest on the third floor, with the feed opening extending through the fourth floor, which will be used as a charging deck.

Scratchers placed on the first and second floors will take the Banbury product. This will deliver scratched composition to a conveyor system serving the calender at its various positions.

By properly scheduling the Plain and Common Goods production, one Banbury Mixing System will serve both departments. An additional 75-foot length of belt conveyor will be needed to serve the Common Calender, which will be moved to a new set of tracks running parallel with the present Battleship calender.

(See Figs. 2 and4)

PLAN OF ARRANGEMENT - BEDFORD AND CEMENT MFG.:

Based upon the recommendation of Wood and Bedford and upon our experience with the experimental unit, it is proposed to install large sized Bedford Kettles. These have the advantage over the small kettles of decreased maintenance, reduced labor and lower initial investment. The Lino Scrim Houses (Buildings 29-A and 29-E) will be remodeled to house all Bedford and Cement making equipment, as well as

storage facilities for the finished products. Briefly, the building changes and equipment necessary are as follows:

1.- Removal of all Scrim Racks and erection of a concrete floor on a level with the first floor over the present Bedford and Cement departments.

2.- Installation of Bedford Kettles on a first floor of 29-E building with straight-forward movement of material to the charging openings over the cement kettles, which will be located in the basement of 29-A building.

3.- Floor dumping and bin storage of Bedford Oil.

4.- Storage bins for cement in basement of 29-E building.

5.- Tramrail conveyance of cement from cooling bins to storage bins.

6.- All units individually motor driven, giving more flexible and efficient operation.

COSTS AND SAVINGS:

The study of installation costs and resulting savings has been arranged in two divisions, namely:

Division I.- Consolidation of Philadelphia and Trenton 1930 Standard Production at Trenton with Litharge Bedford Cement (86,000 equivalent square yards of Medium Brown Battleship per month).

(a) With Banbury Mixing System:

The cost of consolidating the production

with Litharge Bedford Cement and Banbury Mixing will be $93,732.00, and the resulting savings, after deducting 20% for indeterminate factors, will be $101,998.00 per year.

(b) With present mixing system revised for Jaspe:

The cost will be $72,697.00, and the savings, after deducting 20% for indeterminate factors, will be $43,459.00.

Division II.- A comparison of the costs to manufacture the maximum possible square yards of Plains and Commons at Trenton, using Litharge Bedford Cement (106,000 equivalent square yards of Medium Brown Battleship per month).

(a) With Banbury Mixing System:

The cost of the changes will be the same as for I(a), $93,732.00, and the resulting savings, after deducting 20% for indeterminate factors, will be $131,065.00 per year.

(b) With present mixing system revised for Jaspe:

The cost will be $72,697.00, and the savings, after deducting 20% for indeterminate factors, will be $50,726.00.

When using 77% Litharge Bedford Cement, there is an average decrease of 35% in the curing time, which enables the combined production of approximately 86,000

equivalent square yards of Medium Brown Battleship per month to be made in heaters #3 - #8 inclusive, with an excess capacity of approximately 20,000 square yards. To compare the costs of manufacturing this 106,000 equivalent square yards of Medium Brown Battleship at Trenton when using Litharge Bedford Cement and Banbury Mixing with the costs to manufacture the same production with the present formula and mixing systems, the following assumption must be made:

> That Trenton will make approximately 78,500 square yards of Medium Brown Battleship per month and Philadelphia will make the remainder, and also Jaspe and Cork Carpet, since present drying time with Walton Cement will not permit the making of the combined production at Trenton in heaters #3 - #8.

RECOMMENDATIONS:

It is recommended that definite steps be taken to produce all calendered goods at Trenton; to provide facilities for the manufacture of 77% Litharge Bedford Cement to replace Walton and Inlaid Cements and to install the Banbury Mixing System in order to give more uniform mixing at decreased cost.

DETAILED DISCUSSION

OF

PROBLEM E-177

MECHANICAL ARRANGEMENT - CONSOLIDATION

There is available heater space at Trenton when using 77% Litharge Bedford Cement to make all the combined 1930 standard production of Trenton and Philadelphia Battleship, Jaspe and Cork Carpet in heaters #3 - #8 inclusive, and the 1930 standard production of Common Goods in heaters #1, #2 and half of #9. The burlap coating will still be done in heaters #10 and half of #9.

The number of hours' operation necessary for Plains, Jaspe and Commons are entirely practical, so that the various departments will be able to schedule their production to suit their individual needs.

MECHANICAL ARRANGEMENT - BODY MIXING

It is apparent from the study of several trial layouts that the Banbury Mixing System should be installed in 2-C Building. The Banbury Mixer will be located on the third floor so that the charging hopper will protrude through the fourth floor approximately 12 feet, allowing this floor to be used as a charging deck. The machine itself will rest upon 18-inch I-beams which in turn will rest upon the present 24-inch I-beams constituting the third floor structure. These will be reinforced with 6-inch H columns from the ground up.

Directly beneath the Banbury Mixer will be located two complete scratcher units connecting with

the mixer through a double system of chutes for use when making Jaspe. This complete hopper unit will be movable on overhead tracks, permitting its replacement by a single by-pass chute for use when running Battleship, Cork Carpet and Commons.

A mixing platform built above a third scratcher, located on the first floor, will receive the scratched material for Jaspe from the double scratcher system on the second floor. Here it will be manually fed to a mixing box containing a ribbon type conveyor. The scratcher on the first floor will then receive this material and deliver it to an inclined belt conveyor, which, in turn, will deliver it to a shuttle conveyor operating directly over the Battleship calender in 2-A building.

When manufacturing Battleship, Cork Carpet and Common Goods, the double bin from the Banbury Mixer to the scratchers on the second floor can be moved back on overhead rails, and a single by-pass chute connected in place to deliver the Banbury product to the scratcher on the first floor of 2-C building. (This is the scratcher now in 2-A building).

To provide for Common Goods and permit greater flexibility of calender operations, it is advisable to revise the calender layout. The 8/4 Commons calender will be removed from service, and the 16/4 calender placed on a set of rails parallel to

the present rails, but on the opposite side of the room (under the present Commons screw conveyor system). The Battleship 8/4 calender will then be used for both Commons and Battleship, and can run into heaters #1 to #9 inclusive. The 16/4 calender operating on the parallel tracks can run into heaters #1, #2, #3, #8, #9 and half of #4 and #7. It will produce both 12/4 and 16/4 Common Goods.

(See Figs. 2 and 4)

MECHANICAL ARRANGEMENT - BEDFORD AND CEMENT

For the manufacture of Wood and Bedford Oil and 77% Litharge Bedford Cement, a survey of existing buildings shows the present Lino Scrim houses to be the best adapted for this purpose. It will be necessary to make several changes to provide for the most efficient layout. After the removal of all Scrim flooding equipment, racks and cross-beams, a reinforced concrete floor will be laid approximately 12 feet above the basement on a level with the existing first floor in the 43-foot extension over the present cement manufacturing area. The center wall, separating 29A building from 29-E building, will be torn out above the first floor and replaced by supporting columns and cross-beams. The entire dividing wall between the Scrim house proper and the 43-foot extension will be removed in both 29-A building and 29E building from the basement to the roof. This

not only will provide greater accessibility, but will also facilitate the supporting of the floor and roof at this point.

Linseed Oil will be pumped from the present pump house to five large sized Bedford Kettles located, in batteries of two kettles each, perpendicular to the south wall of 29-E building. This grouping will permit the use of a single large cooling area for each pair of kettles.

The kettles will be driven by 60 H.P. motors directly connected to a suitable transmission from which further reduction in speed will be obtained through silent chain drives to the kettles which will operate at 170 R.P.M. and 50 R.P.M. (the recommended speeds).

Each kettle will obtain oxidizing air from one #2 Monogram fan. Bristol temperature recorders will be installed to assist in controlling the process.

Sufficient storage space will be provided to meet the coment production for a four-day period.

The five cement kettles will be located in the basement of 29-A building and its extension along the north wall. Directly above the kettles will be individual charging openings. All the cement ingredients will be located on the first floor. The Kauri Crushing equipment, Rosin Melting Kettle and storage of raw materials will be conveniently located in 29-F building, (the present experimental building) which is

on a level with the first floor and adjacent to 29-E building.

The arrangement of the cement kettles will permit dumping in either direction into cooling pits as production may require. Fifteen H.P. motors connected through worm gear reduction units to obtain the desired speed of 25 R.P.M. will be used to drive the kettles.

A tram-rail system will be employed to deliver the cement to the storage bins in the basement of 29-E building and its extension. There will be suitable buckets for removal of the cement from the cooling pits. These may be lowered while loading and then raised to clear the four-foot high storage bins. Approximately two weeks' storage will be provided.

The existing electric hoist in the west end of this building will raise the cement in pans to the first floor. From there it will be conveyed to the Inlaid Plant or the mixing system in 2-C building. The use of electric trucks such as the Tec truck would be excellent for this work. However, until such time as plant transportation facilities are changed, it is planned to use electric hoists at the end of 29-E building and 201 building at the at the Inlaid (201 building) to load and unload the horse-drawn wagons. Lift-trucks will be employed to handle the cement from this point at the Inlaid to the grinder and also to convey cement to the Battleship mixing in 2-C building

from 29-E building. The cost of this transportation has been included in the cement manufacturing cost.

(See Fig. 4)

POWER REQUIREMENTS

The present 600 K.W. transformer capacity, while sufficient to carry average operating loads which will occur with Banbury Mixing and Litharge Cement manufacture, will be inadequate to meet the starting load, peak loads or slight increases over normal operation. Additional oil switches will be necessary, and in the present location, there is insufficient room for their installation. Because of these conditions, it is proposed to erect the first unit of a sub-station in Reeves field. This is the logical place, since the heaviest load will be in that area. The building will be so constructed that it may readily be extended, should the plant go on a totally purchased power basis, or as individual department needs warrant more purchased power.

The drive, as recommended for the Banbury Mixer, is a 720 R.P.M., 300 H.P. synchronous or slip ring motor. The peak load on a 4-minute cycle will probably be from one to one and a half minutes. At the Philadelphia Plant, in the Inlaid Department, there is idle one 220 H.P., 720 R.P.M. synchronous motor with the required power characteristics. This motor is designed to carry a continuous overload of

25% for two hours and should amply carry an intermittent load of 300 to 325 H.P. for the peak period. Farrel-Birmingham feel that this motor would be well suited for the work required. It is equipped with self-contained field excitations, panel control board, etc. By utilizing this motor, there would be realized a saving in initial cost of approximately $4,000.00. It would be necessary to remove the out-board bearing which is now a part of the Philadelphia installation and to cut off approximately 26 inches of bedplate and shaft. The motor would be directly connected through a suitable flexible coupling to the #5 Farrel-Birmingham herringbone speed reducer.

Since both Commons and Battleship body mix will be made with the same system, only one calender will operate at a time. Also, the installation of a Banbury Mixer will make obsolete all the equipment, except the scratcher now used for Battleship body mixing, which is either driven electrically or mechanically from the Brown engine. By installing a 40 - 50 H. P., 440 A.C. motor (which can be obtained from Philadelphia) on this scratcher, the entire load on the Brown engine can be eliminated and the engine shut down.

The power for Bedford and Cement equipment will all be purchased power.

INSTALLATION COSTS

COST OF BANBURY MIXING INSTALLATION

BANBURY EQUIPMENT:

(1)	1 #11 Banbury Mixer, f.o.b. Derby, Conn. ..	$18,750.00
(2)	Freight.....	300.00
(3)	1 #5 250 H.P. Herringbone Gear Reduction for the above.....	2,600.00
(4)	2 Flexible Couplings (High and Low Speed)..	575.00
(5)	Erection (Contractor).....	800.00
(6)	Erection (Trenton Shop).....	400.00
(7)	Removal and Revision of the bedplate on 220 H.P. synchronous motor from Phila.....	600.00
(8)	Electrical Installation.....	590.00
(9)	Move 16/4 Calender, Foundation, Rails, Contractor, etc.....	2,525.00
(10)	Conveyor Electrical Installation.....	158.00

BUILDING CHANGES:

(1)	Reinforce third floor with 18" I-beams for two bays of length.....	800.00
(2)	Reinforce present beams with columns.....	700.00
(3)	Power service to #2-C building.....	655.00
(4)	Additional transformer capacity $\frac{45500}{148600}$x4400.	1,350.00

SCRATCHER CHANGES:

(1)	Remove present scratcher from 2-A building to 2-C building, erect on foundation...	400.00
(2)	Equip 50 H.P. 440 A.C. Motor (from Phila.).	300.00
(3)	Electrical installation--labor and material	420.00

(4)	Chutes and hopper from Banbury Mixer to scratcher on first floor.....	350.00
(5)	Inclined conveyor from scratchef to shuttle conveyor.....	650.00
(6)	Shuttle conveyor, one 75' section to #3 heater.....	2,680.00
(7)	One 75' section from #3 heater to end Commons Calender.....	2,708.00
(8)	Removal of obsolete equipment.....	700.00

ADDITIONAL FOR JASPE BODY MIXING:

(1)	Move two scratchers with motors from Philadelphia.....	150.00
(2)	Two Spur Gear Reducers 9/1.....	1,000.00
(3)	Installing Scratchers, Reducers, Motors..	600.00
(4)	Electrical Installation.....	300.00
(5)	Two 10 H.P. Motors.....	310.00
(6)	Two Chain Drives.....	200.00
(7)	Hoppers, etc.	900.00
(8)	Conveyors, Mixers, etc.	800.00
(9)	Platform.....	400.00
		$43,671.00
	Contingency.10%.....	4,367.00
	Total.....	$48,038.00

COST OF WOOD AND BEDFORD INSTALLATION

OXIDIZING EQUIPMENT:

(1) Four additional large-size kettles at $1600.00	$ 6,400.00
(2) Four blowers at $64.78	259.12
(3) Four recording thermometers at $53.60	214.00

MOTORS AND STARTING EQUIPMENT:

(1) Five 60 H.P. motors for kettles at $411.30	2,056.50
(2) Starting equipment for same at $170.10	680.40
(3) Four 1½ H.P. motors for fans and four complete starting units for same at $60.30	241.20

MECHANICAL DRIVES AND ACCESSORIES:

(1) Four additional "Speed Boxes" - $291.43.	1,165.72
(2) Four high-speed flexible couplings at $22.73	90.92
(3) Four low-speed flexible couplings at $22.73	90.92
(4) Four Texrope drives for fans - $29.94	119.76
(5) Four silent chain drives for kettles at $264.00	1,056.00
(6) Four cast iron bases for transmission at $30.00	120.00
(7) Four lock-tight gear shifts at $10.00	40.00
(8) Four jack-shaft units (incl. two SKF bear. and hang.) at $25.00	100.00

MISCELLANEOUS ITEMS:

(1) Three sheet metal dumping chutes at $10.00...	30.00
(2) Unit heaters.....	252.00
(3) Watt-hour meter.....	400.00
(4) Installation of three fans and air ducts.....	60.00
(5) Installation of one oil pump and line.....	35.00
(6) Move one Bedford Kettle from 20-F to new location in 29-E, and removal of all equipment from 29-F.....	150.00
Total.....	$26,413.12
Contingency 10%.....	2,641.31
	$29,054.43

BUILDING CHANGES:

(1) Tearing out Scrim Flooding Equipment.....	$ 782.00
(2) Tearing out center wall and erecting steel supporting columns.....	350.00
(3) Erecting 1st floor 29-A and 29-E buildings.	4,030.00
(4) Erecting permanent Bedford cooling areas...	110.00
(5) Erecting permanent Bedford storage bins....	350.00
(6) Tearing out end wall and floor 20-A and 29-E buildings and erecting supports in place of end wall.....	200.00

INSTALLATION:

(1) Installation of Bedford Kettles and Drives.	450.00
(2) Erection of power line.....	945.00

$$\frac{(81250 \times 1198.50)}{103100}$$

(3) Removal of four Bedford Kettles from cars at $54.00.....	216.00
(4) Electrical wiring and erection of panel board.....	1,985.00
(5) Installation of electric lights.....	275.00
(6) Piping of water, oil and steam--material, $275.00; labor, $210.00.....	485.00
(7) Laying separate water main from pump house.	550.00
(8) Installation of heating system.....	150.00
(9) Steam traps - four at $16.27.....	65.08
(10) Installation of additional transformer-- Cap. $\frac{(81250 \times 4400)}{148600}$.....	2,403.00

COST OF 77% LITHARGE BEDFORD CEMENT INSTALLATION

CEMENT KETTLES AND AUXILIARY EQUIPMENT:

(1) Move two Cement Kettles from Inlaid to position in basement of 29-A building.....	550.00
(2) Move two Cement Kettles with motors and reducing units from Philadelphia to position in 29-A building.....	600.00
(3) Kauri Gum Grinding Equipment--remove from Philadelphia, with complete drive and sieving enclosure, and install in 29-F building.....	350.00
(4) Move one kettle from Lino to new position.	50.00
(5) Rosin melting equipment--remove from Philadelphia and install in 29-F building.	675.00

MOTORS AND STARTING EQUIPMENT:

(1) Three 15 H.P. motors for cement kettles, complete with push button starting equipment, at $224.10.....	672.30
(2) Two additional complete starting units for 15 H.P. motors.....	60.00

MECHANICAL DRIVES AND ACCESSORIES:

(1) Three worm gear reducers for cement kettles at $425.00.....	1,275.00
(2) Three high-speed flexible couplings for kettles at $13.64.....	40.92
(3) Three low-speed flexible couplings for kettles at $76.95.....	230.85

(4) Five concrete foundation bases for drives at $25.00.....	125.00
BUILDING CHANGES:	
(1) Clearing 29 building of obsolete equipment and leveling basement floor.....	500.00
(2) Erection of storage bins in basement of 29-E building.....	900.00
(3) Cutting two doorways and bricking up dividing wall in extension.....	250.00
(4) Tearing out end wall--basement 29-A and 29-E and erection of support in place of end wall.....	300.00
INSTALLATION:	
(1) Installation of five cement kettles at $110.00.....	550.00
(2) Installation of heating system.....	100.00
(3) Erection of ventilating hoods over cement kettles (including exhauster fans).....	775.00
(4) Electrical wiring and erection of panel board.....	824.00
(5) Erection of power line ($\frac{21850}{148600}$ x 1198.50)...	253.50
(6) Installation of additional transformer-- Cap.- ($\frac{21850}{148600}$ x 4400).....	647.00
(7) Piping of steam.....	375.00
(8) Installation of adequate lighting system...	240.00

MISCELLANEOUS ITEMS:

(1) Cleveland Tramrail--installed.....	1,883.00
(2) Trailers for cement transportation, hoists	2,000.00
(3) Erection of cooling pits for cement.....	85.00
(4) Provision for charging area in extension of 29-A building for 5th cement kettle....	250.00
(5) Addition of steam line to 29 building.....	565.00
Total.....	15,127.42
Contingency 10%.....	1,512.74
	$16,640.16

SUMMARY OF INSTALLATION COSTS

Banbury Mixing System.....	$48,038.00
Bedford Oil.....	29,054.00
Litharge Bedford Cement.....	16,640.00
Total Costs.....	$93,732.00

SAVINGS

The savings which result from the installation of improved mixing equipment and 77% Litharge Bedford Cement manufacturing facilities have been divided into three parts, as follows:

(a) Savings due to improved formulae, thereby reducing the material cost.

(b) Savings which result from increased efficiency of manufacture.

(c) Other savings effected as the result of (a) and (b)

The basis for the calculations of savings is the January 1930 Standard Production of Battleship and

Commons at Trenton; and of Battleship, Jaspe and Cork Carpet at Philadelphia. Furthermore, while Philadelphia is in the process of converting its cement production over to the 77% Litharge Bedford Cement basis, the assumption has been made that the 1930 production is on that basis.

(a) Material or Formulae Savings:

The production requirements of body mix for all types of calendered goods have been broken down, and the total raw material cost obtained for Trenton and Philadelphia production on the standard formulae basis. Also, the raw material cost to make the 1930 standard production of Inlaid Cement has been calculated since this product also will be replaced. The total of these items has been compared with the raw material costs when both Philadelphia and Trenton Production are made at Trenton with 77% Litharge Bedford Cement.

(b) Manufacturing Savings:

In calculating the savings under this heading, the following assumptions have been made in order to arrive at a true comparison:

(1) That Philadelphia Scrim standards have been eliminated, due to the conversion to 77% Litharge Bedford Cement.

(2) That the combined plan at Trenton will carry in its manufacturing costs all Indirect Labor charges.

(3) That 50% of all Power and Heat charges

of departments shut down at Philadelphia and Trenton will be carried in the combined plan at Trenton.

(4) That all Indirect Service and Supply charges will be borne at Trenton.

(5) That 50% of all Repair Charges of defunct departments at Philadelphia and Trenton will be carried at Trenton.

(6) That all present Fixed Expenses will be borne along with additional Fixed Expenses of the combined plan at Trenton.

(C) Other Savings:

A decrease of 35% in curing time may either be replected by a saving in process steam or used to increase heater capacity. This latter view has made possible the consideration of combining Philadelphia and Trenton calendered production at Trenton.

A saving, additional to the material and manufacturing saving, occurs through the elimination of Scrim Oil. The long period of time required to make scrim, and the subsequent necessity of keeping a large stock on hand, results in a loss of interest on the money invested. If this charge is eliminated, it is a saving directly attributable to the Wood and Bedford Process and should be included.

For detailed information regarding the source and calculation of costs and savings, see the Addenda, a copy of which is available in the engineering office.

The sub-division of costs and savings, as outlined earlier in this report is here repeated for easy reference:

DIVISION I - Consolidation of Philadelphia and Trenton 1930 Standard Production at Trenton, with Litharge Bedford Cement (86,000 equivalent square yards of Medium Brown Battleship per month.)

(a) With Banbury Mixing System.

(b) With present mixing system revised to produce Jaspe.

DIVISION II - A comparison of the costs to manufacture the maximum possible square yards of Plains and Commons at Trenton, using Litharge Bedford Cement (106,000 equivalent square yards of Medium Brown Battleship per month.)

(a) With Banbury Mixing.

(b) With present mixing system revised to produce Jaspe.

SUMMARY OF TOTAL SAVINGS UNDER DIVISION I

(86,000 equivalent square yards of Medium Brown Battleship)

Item	(a) Litharge Cement & Banbury Mixing	(b) Litharge Cement & Present System Revised
Raw Material	$ 4,213.00	$ 4,213.00
Manufacturing	5,861.00	237.00 loss
Monthly savings	10,074.00	3,976.00
	x 12	x 12
Annual Savings	120,888.00	47,712.00
Annual Scrim Carrying Charges at 6%	6,612.00	6,612.00
Gross Annual Savings	127,498.00	54,324.00
Less 20% for indeterminate factors	25,500.00	10,865.00
Net Annual Saving	$101,998.00	$43,459.00

Ratio of Cost to Savings $\frac{93,732}{101,998}$ = .916 yrs. $\frac{93,732}{43,459}$ = 2.16 yrs.

The loss sustained in manufacturing cost when the present mixing system is used for the combined production, is accounted for by the high labor cost and extreme maintenance inherent in this type of mixing.

It has been thought advisable to include in this report a comparison of savings which might be expected if the maximum heater capacity at Trenton, when using 77% Litharge Bedford Cement, were utilized. To obtain a fair comparison of savings, the total cost of producting the 105,905 equivalent square yards of Medium Brown Battleship per month at Trenton, in heaters #3 to #8 inclusive, and also of the maximum production of Common goods in heaters #1, #2 and half of #9, has been compared to the cost of making the same production under present conditions. Since the present drying time of Battleship will not permit this production at Trenton, it has been assumed that only Medium Brown Battleship would be made here; the excess requirements of Battleship would be made at Philadelphia with the standard set for Jaspe and Cork Carpet. The Commons production of 179,100 square yards could be made at Trenton, as no decrease in drying time is expected with Litharge Cement.

The method of calculation and the assumptions remain the same as under Division I.

SUMMARY OF TOTAL SAVINGS UNDER DIVISION II

(106,000 equivalent square yards of Medium Brown Battleship)

Item	(a) Litharge Cement & Banbury Mixing	(b) Litharge Cement and Present System Revised
Raw Material	$ 5,118.00	$ 5,118.00
Manufacturing	6,942.00	385.00 loss
Monthly Saving	12,060.00	4,733.00
	x 12	x 12
Annual Saving	144,720.00	56,796.00
Annual Scrim Carrying Charges	6,612.00	6,612,00
Gross Annual Saving	151,332.00	63,408.00
Less 20% for indeterminate factors	30,266.00	12,682.00
Net Annual Saving	$121,065.00	$50,726.00

The costs of installation for maximum production will not decrease, as the equipment necessary for standard production will also meet maximum requirements.

CONCLUSION

The installation of these changes should have a material effect upon reduction of sales resistance through the improvement in surface, color, etc., and through the decrease in cost. Should requirements be increased beyond the 20,000 square yards additional capacity over 1930 combined standards, it would be necessary to sacrifice Common Goods heaters to obtain the necessary heater space. This, of course, is considerably in the future, but it is well to bear in mind the limitations of increased production.

From the date of approval of the necessary expenditures to the start of the new equipment in operation. it would require eight months, more or less, dependent upon delivery of equipment, schedule of production and amount of finished scrim on hand.

RATE OF EXPENDITURE

First two months.....	$ 5,000.00
Second two months.....	10,000.00
Third two months.....	40,000.00
Fourth two months.....	28,732.00
Total for eight months....	$93,732.00

HEATER CAPACITIES

A	B	C	D	E	F	G	H
				Pipe Days Per Mon.		Pcs. Med. Brown per Mon.	
Heater	Number	Length	Equi. 8/4	100% eff.	90% eff.	100% eff.	90% eff.
No.	Pipes	Pipe	Pipes	E=D x 30	F=E x .90	G=E ÷ 91.76	H=F ÷ 91.76
1	400	8/4-16/4	590	Battleship Calender will not reach			
2	333	8/4-16/4	498	14,940	13,446	163.0	146.70
3	390	16/4	780	23,400	21,060	255.4	229.86
4	403	16/4	804	24,120	21,708	263.0	236.70
5	362	16/4	724	21,720	19,548	236.9	213.21
6	323	16/4	646	19,380	17,442	211.5	190.35
7	330	16/4	660	19,800	17,820	216.0	194.40
8	368	16/4	736	22,080	19,872	241.0	216.90
9	370	8/4-16/4	590	17,700	15,930	193.2	173.88
10	Coating	-	-				

Note:- Heater Efficiency = 90%

Average piece in heaters contains 91.76 square yards

Heaters Nos.	Total No. 8/4 Pipes	Pipe Days per Mon. at 90% Efficiency	Pieces Med. Brown per Mon. at 90% Efficiency	Max. No. Sq. Yds. Med. Brown per Mon. (Walton Cement)		Heater Capacity Sq. Yds. Med. Brown per Month (Lith. Cement)
4 - 7 inc.	2834	76,518	834.66 x 61.22	51980 x 1.35	=	70,173
3 - 8 inc.	4350	117,450	1281.42 x 61.22	78449 x 1.35	=	105,905
2 - 9 inc.	5438	146,826	1602.00 x 61.22	98074 x 1.35	=	132,400

1930 Battleship and Plains Standard = 57,000 Sq. Yds. (Med. Brn. Basis) into heater.

1930 Common Body Standard..... = 148,500 Sq. Yds. per Month.

1930 Philadelphia Standard..... = 28,951 Sq. Yds. (Med. Brn. Basis.)

1930 Combined Standard Philadelphia and Trenton..... = 85,951 Sq. Yds. (Med. Brn. Basis.)

Note:- Average decrease in Drying Time effected by 77% Litharge Wood and Bedford Cement = 35%

BEDFORD KETTLES REQUIRED

Bedford Production 1930 Proposed Standard for Philadelphia and Trenton Production at Trenton will be 464,991 pounds per month.

Recommended Batch = 187 lbs. per hour

Recommended Cycle = 15 hours

Gross Yield = 187 x 15 = 2,800 lbs.

Assume kettle operates twenty-six days per month, at twenty-four hours per day; clean kettle four times per month, which equals two days. Net operating time per kettle equals twenty-four days per month.

Therefore, Production

of one kettle per mon. = $\frac{24 \times 24}{15} \times 2800 = 107{,}800$ lbs.

No. of kettles

required = $\frac{464{,}991}{107{,}800} = 4.30$

Therefore, kettles

proposed = 5

No. of kettles required for Maximum

Production = $\frac{548{,}259}{107{,}800} = 4.98$

For a margin of safety, the department could be operated thirty days per month.

CEMENT KETTLES REQUIRED

77% Litharge Bedford Production - 1930 proposed for standard consolidated production of Trenton and Philadelphia equals 603,885 lbs. per month.

Recommended Batch = 1,322 lbs.

Recommended Cycle = 4 1/2 hrs.

Assume twenty-three-day operation per month.

Assume twenty-four hours cleaning per month.

Therefore, net operation per kettles = 22 days per month.

Kettle monthly production = $\frac{22 \times 24}{4\ 1/2} \times 1336 = 157,000$ lbs.

Number of kettles required = $\frac{603,885}{157,000} = 3.58$

Proposed to install = four kettles

Number of kettles required for Maximum

Production = $\frac{699,350}{155,000} = 4.45$

Proposed to install = five kettles

BREAK-DOWN OF RAW MATERIAL QUANTITIES - TRENTON

MONTHLY BASIS - 1930 STANDARD

(57,000 Equiv. Sq. Yards of Medium Brown Battleship)

Body Mix - Medium Brown Battleship - 587,000 lbs. = 4098.42 batches

143 1/4 lbs.	Ground Cork	50 lbs.	204,921 lbs.
	Woodflour	10 lbs.	40,984 lbs.
	Walton Cement	65 lbs.	266,397 lbs.
	Peru Ochre	14 lbs.	57,378 lbs.
	Red Lead	4 lbs.	16,394 lbs.
	Drop Black	4 oz.	1,025 oz.

Common Body Mix - 386,000 lbs. = 3190.91 batches

121 lbs.	Ground Cork	50 lbs.	159,546 lbs.
	Woodflour	10 lbs.	31,909 lbs.
	Penna. Ochre	15 lbs.	47,864 lbs.
	Candle Tar	12 lbs.	38,291 lbs.
	Walton Cement	9 lbs.	28,718 lbs.
	Taylor Oil	22 lbs.	70,200 lbs.
	Red Lead	3 lbs.	9,573 lbs.

Walton Cement - 295,115 lbs. = 215.41 batches

1370 lbs.	Rosin	250 lbs.	53,853 lbs.
	Kauri	75 lbs.	16,156 lbs.
	Scrim	850 lbs.	183,099 lbs.
	Bedford	225 lbs.	48,467 lbs.
	Dom. Whiting	15 lbs.	3,231 lbs.

Taylor Cement - 70,200 lbs. = 62.67 batches			
1120 lbs.	Blown Oil	145 gal.	1,087 gal.
Bedford Oil - 48,467 lbs. = 24.65 batches			
1966 lbs.	Linseed Oil	231 gal.	5,694 gal.
	Dom. Whiting	140 lbs.	3,451 lbs.
	Red Lead	5 lbs.	123 lbs.
	Litharge	5 lbs.	123 lbs.
	Dom. Whiting	17 lbs.	419 lbs.
Blown Oil - 9,087 gal. = 10.38 batches			
875.2 gal.	Linseed Oil	900 gal.	9,342 gal.
	Red Lead	65 lbs.	675 lbs.
	Litharge	65 lbs.	675 lbs.
Scrim Oil - 183,099 lbs. = 1830.99 batches			
100 lbs.	#61 Oil	96.5 lbs.	176,691 lbs.
	72"-muslin	1.76 yds.	3,223 yds.

GLOSSARY

The following glossary is added as an explanation to those not familiar with linoleum manufacture:

B

Banbury Mixer - A machine developed by Mr. John Banbury for use in the plastic industries. It utilizes both the principles of kneading and differential grinding. It is manufactured by the Farrel-Birmingham Company of Ansonia, Connecticut.

Battleship - A gray, green, brown or black heavy-weight linoleum made on a calender, so called because it has been for many years the choice of floor covering throughout the upper deck interiors of battleships and passenger liners.

Bedford Cement or Oil - A blown, viscous oil resembling crepe rubber in appearance, made by heating and agitating linseed oil, red lead, litharge and whiting in a large cylindrical kettle under air pressure.

Body Mix - The warm, plastic ingredients, thoroughly kneaded and ground into a uniform mass, ready to be applied to the backing by calendering. (See Body Mix Formula)

C

Calender - A machine with two rolls set either in a horizontal or vertical plane, used to compress plastic material into sheets of the desired thickness. Driven electrically or by steam through counter shafting. The rolls are driven at a ratio of 1 : 1. In the manufacture of linoleum, the plastic body mix is compressed into the burlap backing.

Commons - Goods lighter weight in gauge than Battleship and cheaper in quality, designed to carry a printed surface.

I

Inlaid Linoleum - Medium to heavy weight linoleum, cut out into the components of the particular pattern by dies, then pieced together to form finished pattern design. Immense presses are used to solidify the entire sheet.

J

Jaspe' - A middle-weight Battleship linoleum, variegated in color, usually a green, gray or brown base with a streaking of white or lighter shades of the base occupying 25 to 30% of the area in an irregular, mottles pattern.

K

Kauri Gum - A hard, resinous fossil gum dug up from areas in the Congo and Borneo.

L

Litharge Cement - A cement similar to the older-style Walton Cement, with the new Wood and Bedford Cement as an ingredient, and with varying amounts of litharge dryers to adjust it to its particular purpose and to the New Jersey climate.

S

Scratcher - A machine with two revolving rolls having protruding teeth or pins and used to shred or disintegrate a plastic mass into granular form.

Scrim Oil - The layers of oxidized linseed oil built up by slow oxidation upon a base of scrim cloth. Traveling pans of linseed oil pass over vertical racks upon which scrim cloth is hung. After approximately three months, the layers have built up to a thickness of 3/4" to 1 1/4". The long sheets of scrim are then cut down and stored as 2' to 3' square sheets with wood flour between sheets to prevent sticking.

W

Walton Cement - A dark-colored, very adhesive cement made by heating rosin, kauri gum, scrim, Bedford Cement and domestic whiting. Used as a binder for Battleship Body Mix.

W

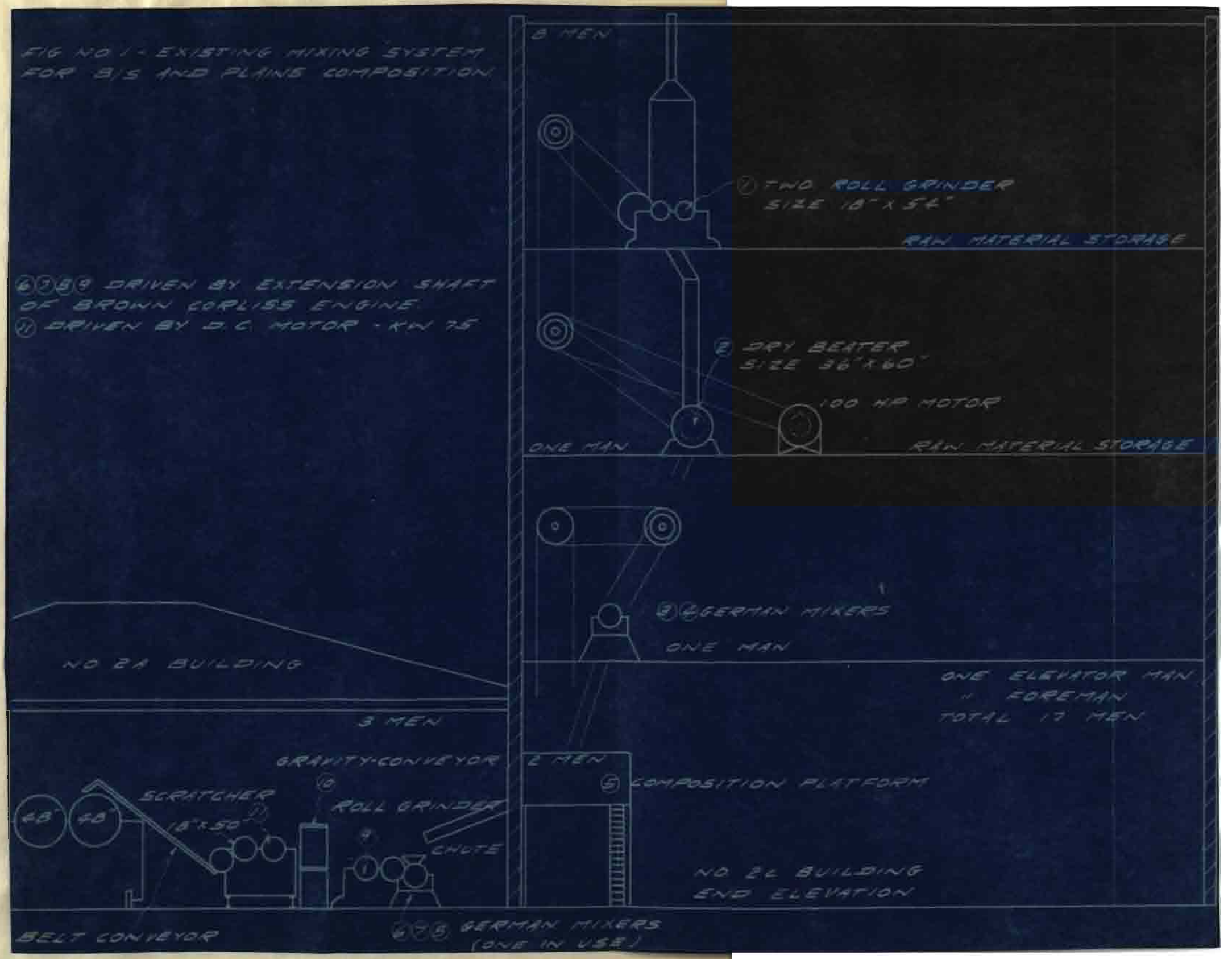
Widths of Linoleum - 8/4 = 6'

12/4 = 9'

16/4 = 12'

Wood and Bedford Cement - An improved Bedford Cement based upon the formula developed by Wood and Bedford, Ltd., consulting linseed oil chemists of Liverpool, England.

FIG NO 1 - EXISTING MIXING SYSTEM FOR B/S AND PLAINS COMPOSITION



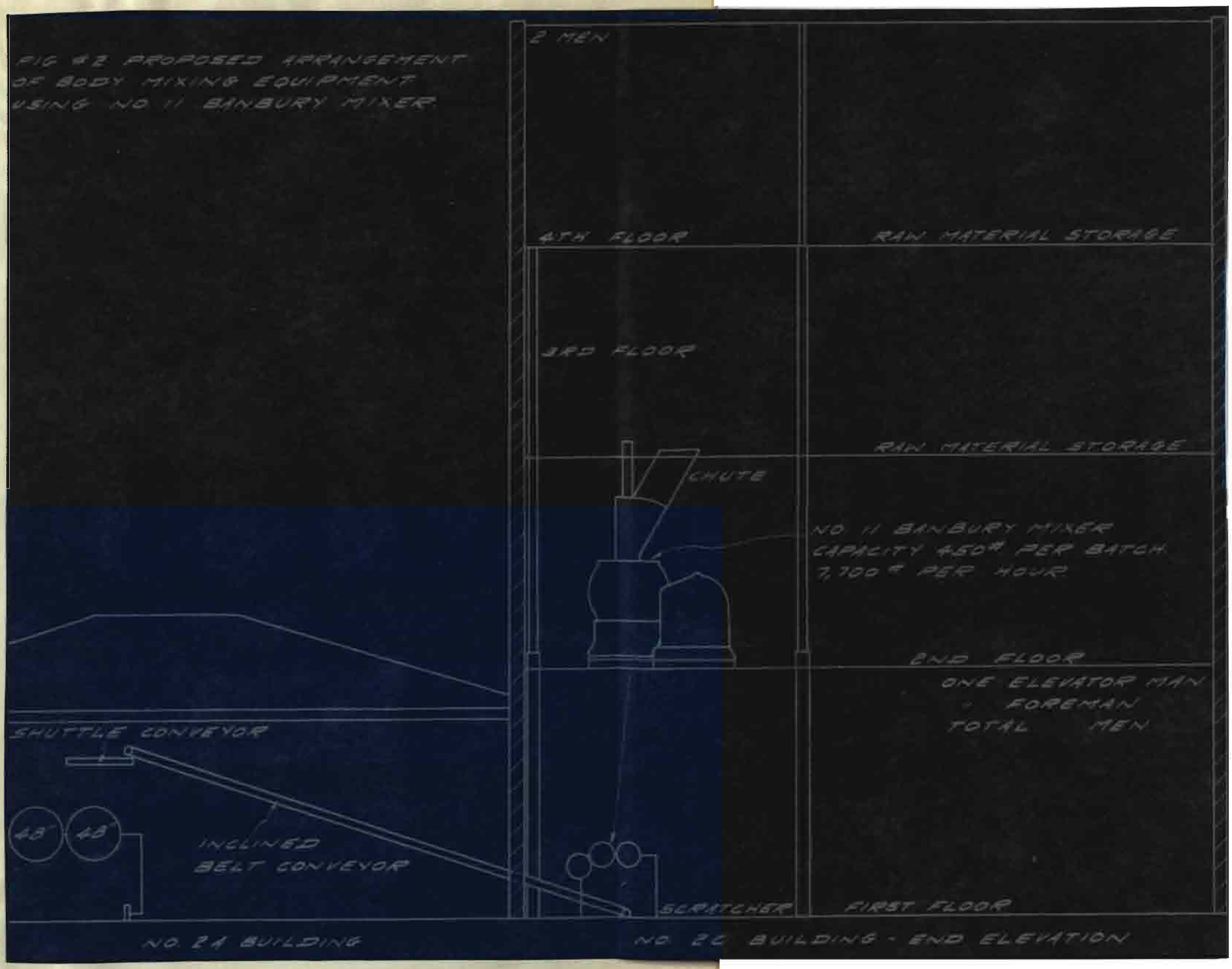


FIG #2 PROPOSED ARRANGEMENT OF BODY MIXING EQUIPMENT USING NO 11 BANBURY MIXER

FIG # 3 PROPOSED ARRANGEMENT OF BODY MIX EQUIP USING NO 11 BANBURY MIXER

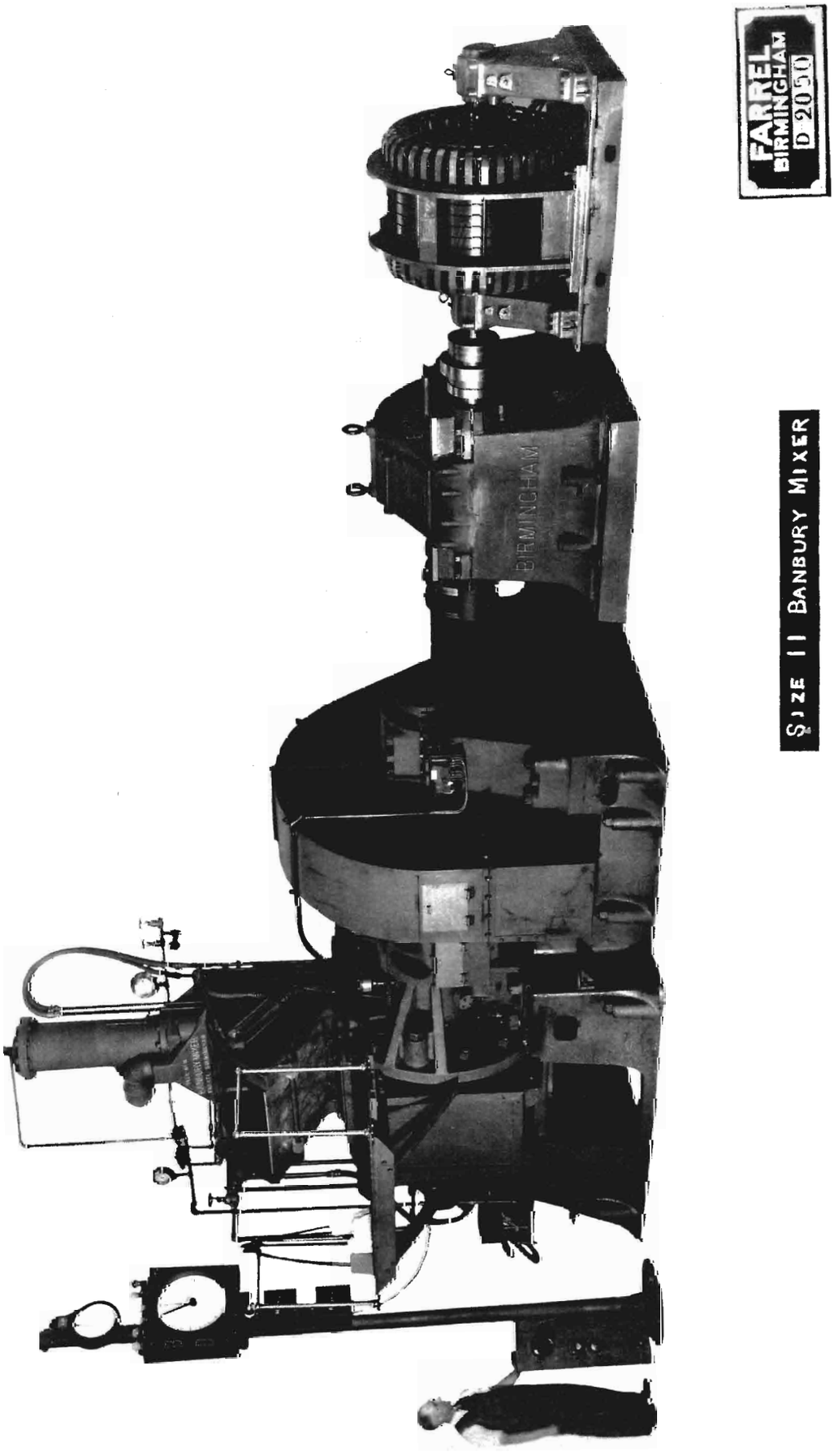


Fig. #4.

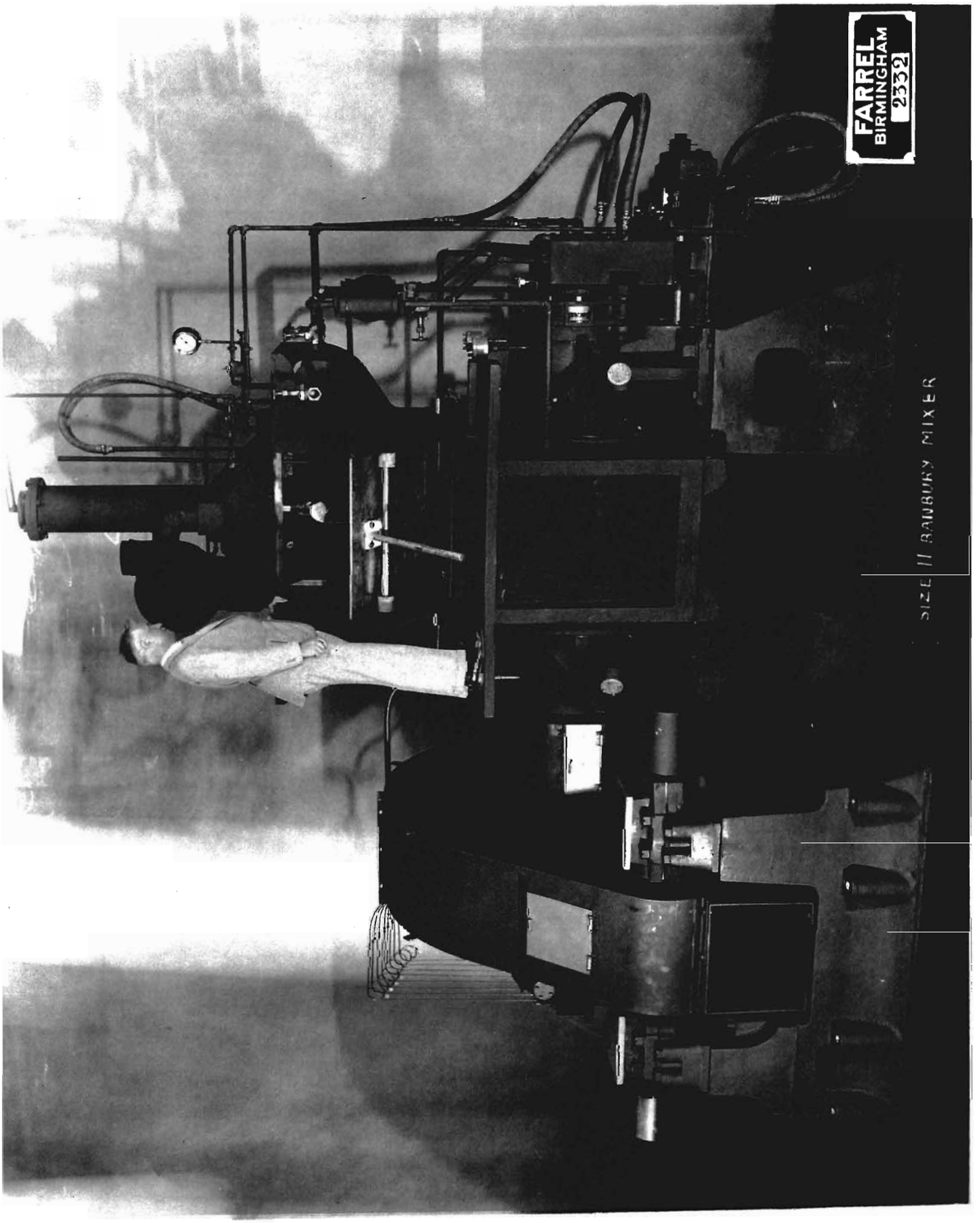


Fig. #5

MATERIAL CHART

Plain Linoleum - Battleship

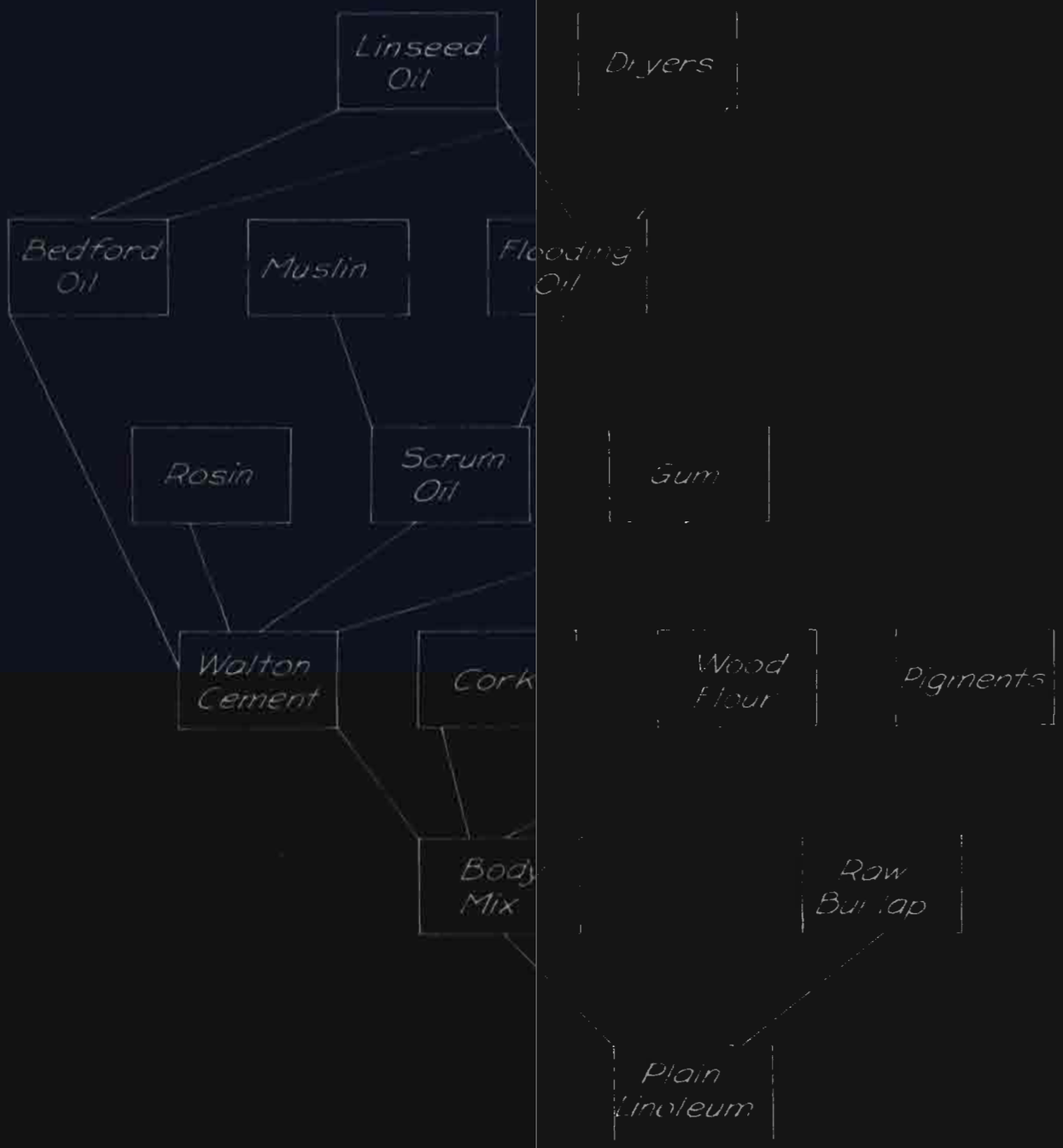


Fig 6

MATERIAL CHART

Printed Linoleum

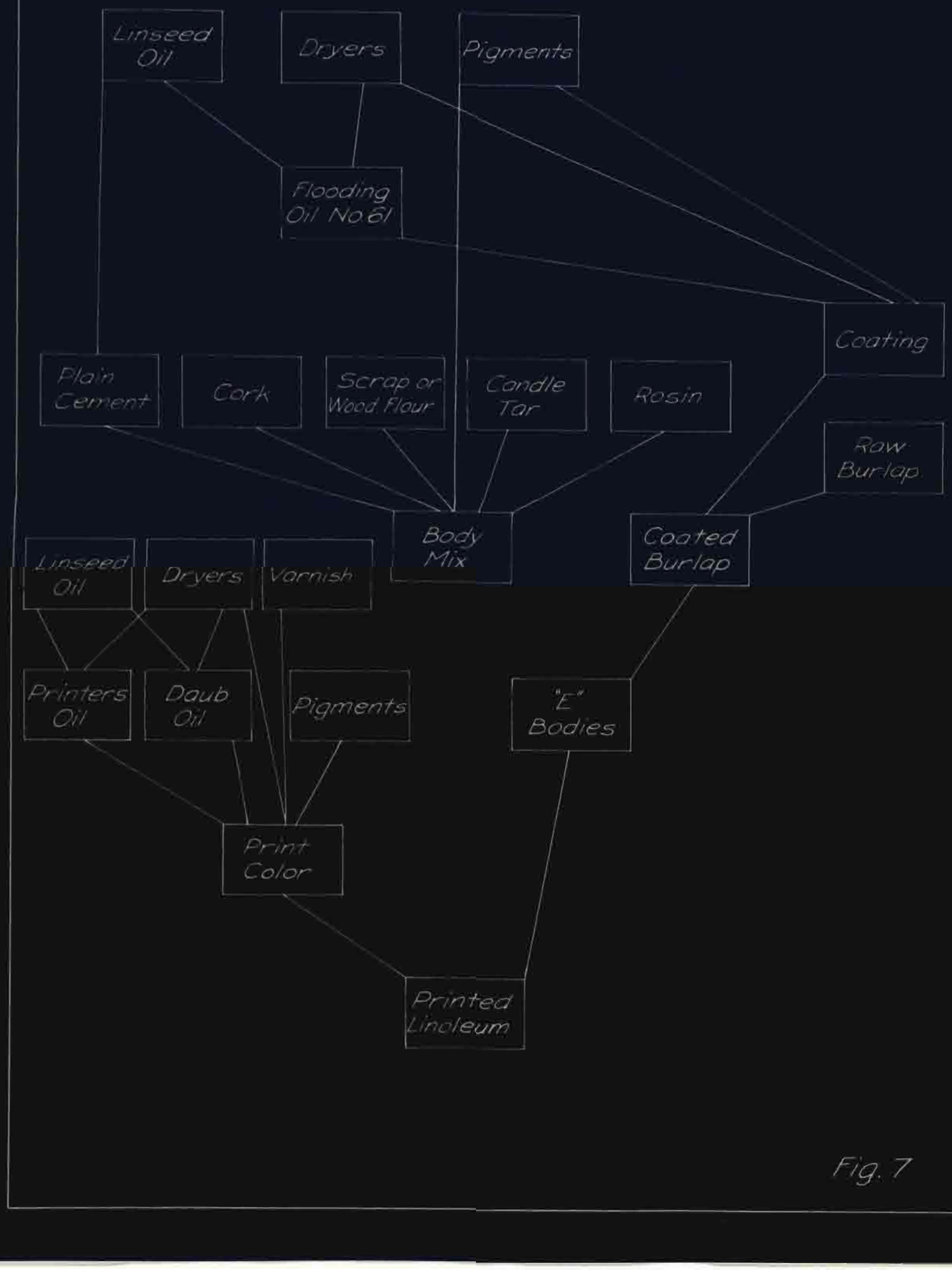


Fig. 7

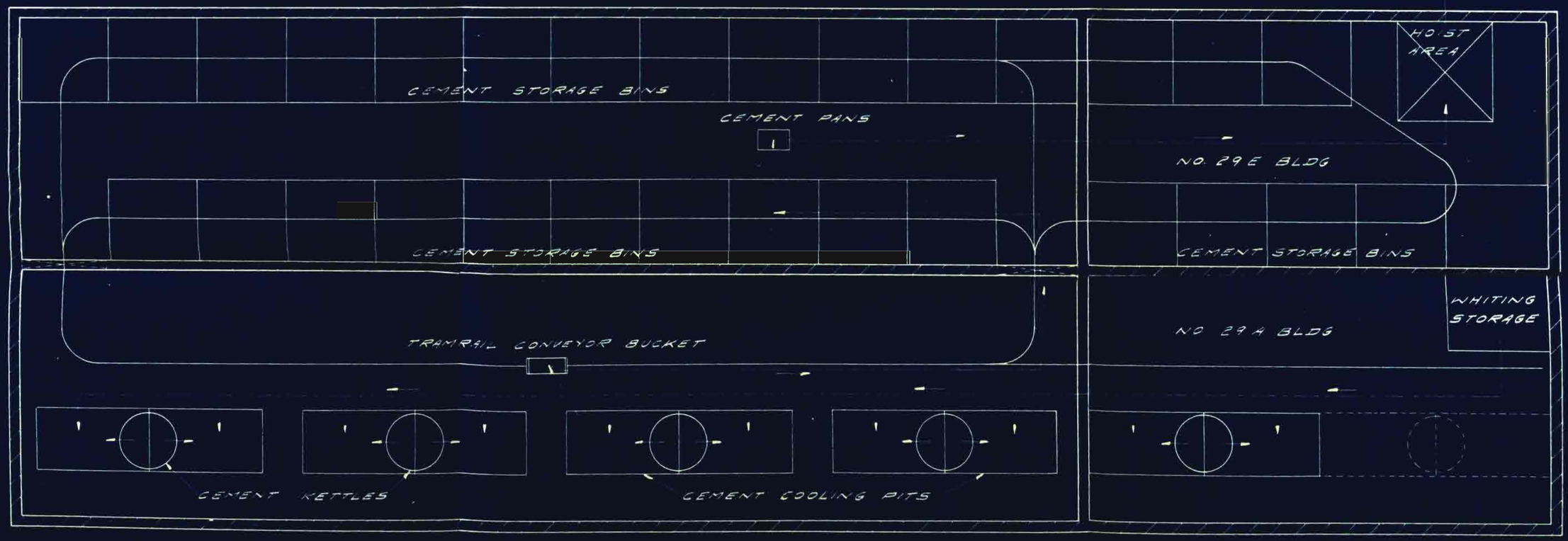
DIAGRAMATIC LAYOUT SHOWING FLOW OF MATERIALS FOR WOOD-BEDFORD OIL AND LITHARGE BEDFORD CEMENT

FIRST FLOOR PLAN

LEGEND

RAW LINSEED OIL	BEDFORD OIL
OXIDIZING AIR	ROSIN
LITHARGE	SIEVED KAURI GUM
WHITING	CEMENT

CEMENT PANS ELEVATED TO FIRST FLOOR BY ELECTRIC HOIST



BASEMENT PLAN

FIG-2
FLOW SHEET
2-14-30 A.C

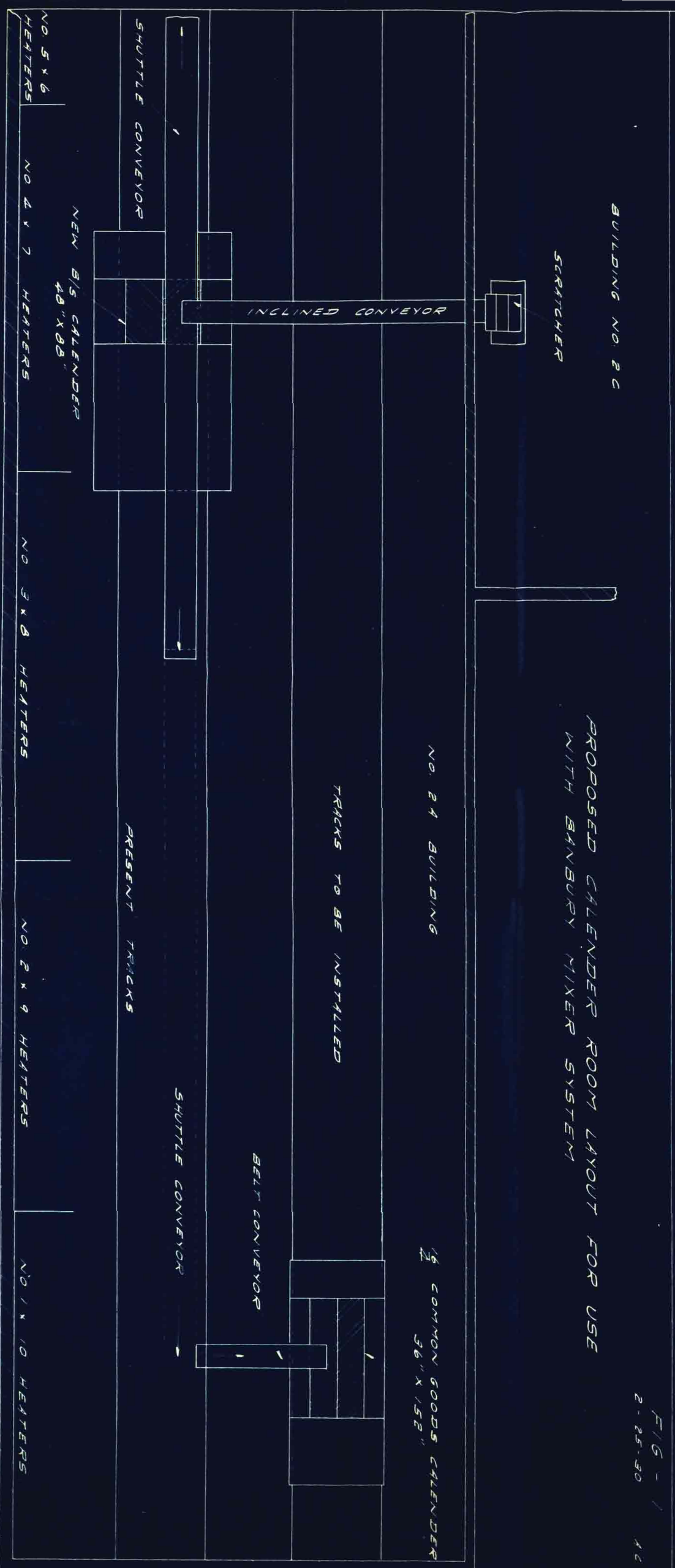
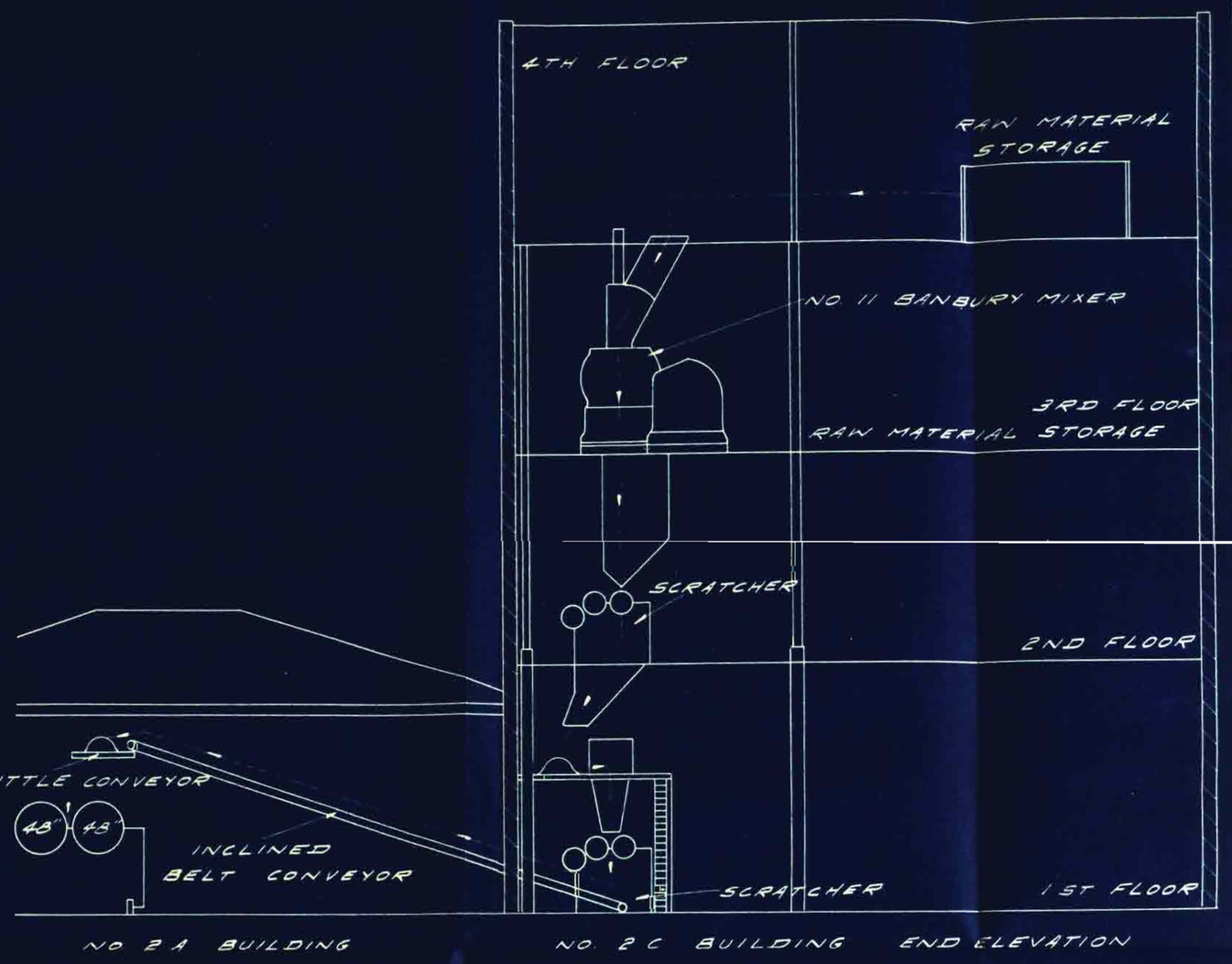
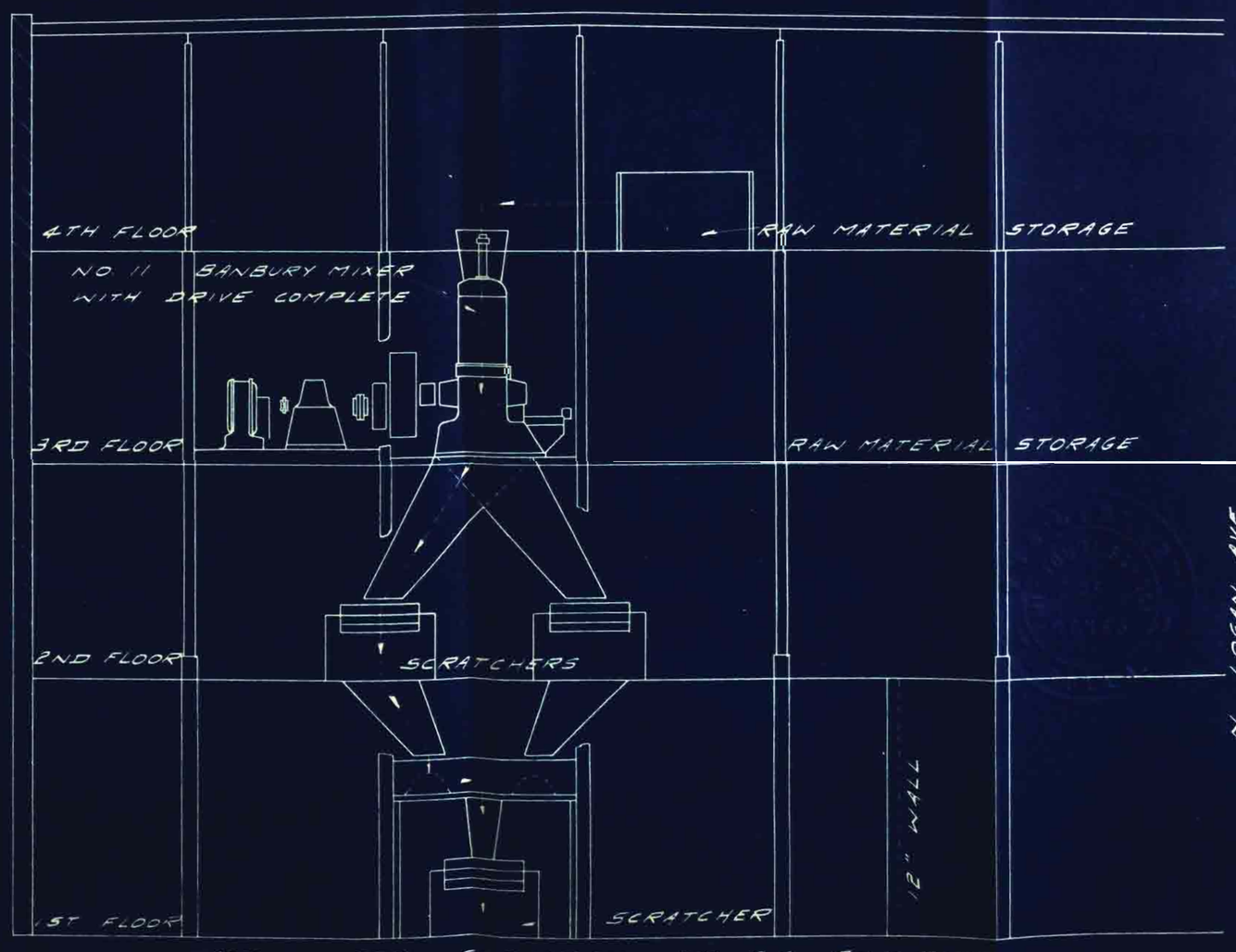


FIG - 1
2-25-30



PROPOSED ARRANGEMENT OF BODY MIXING EQUIPMENT USING NO. 11 BANBURY MIXER.



EAST - WEST ELEVATION - NO 2C BUILDING