Fall 11-7-1954

United States Gypsum's Heath Plant

Harold L. Coolidge

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Report on

UNITED STATES GYPSUM'S HEATH PLANT

For

Metallurgy 53
Montana School of Mines

By

Harold L. Coolidge

Butte, Montana

November 7, 1954
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Department of Metallurgy
Montana School of Mines
Butte, Montana

Gentlemen:

In accordance with your instructions at the beginning of the semester, I submit the following report on the United States Gypsum's Heath Plant.

The report is submitted in fulfillment of the course -- Metallurgy 53.

Sincerely,

Harold L. Coolidge

Harold L. Coolidge
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FIG. I HEATH PLANT — LOOKING EAST

The Heath plant is built on a hillside of a valley on the East Fork of Spring Creek in Central Montana. Located in the foreground of the picture may be seen a portion of the modern board plant, constructed of tile. Notched into the hill above the boardplant may be seen the steel and concrete mill building. Near the upper left-hand corner of the mill may be seen the snowshed, which houses the conveyor from the mine. In the background of the picture is located the hillside in which the old mine workings are located. The new mine workings are located about one-half mile north of the plant.
REPORT ON UNITED STATES GYPSUM'S HEATH PLANT

PLANT HISTORY

The United States Gypsum Company's Heath plant, which is located at Heath, Montana, is one of forty-six diversified production facilities for the development and production of gypsum products. The Heath plant is located about twelve miles southeast of Lewistown, Montana (see map of Central Montana, page 2), and consists of a mine, a mill and a boardplant. The Heath plant was built in 1925 by the Northwest Gypsum Company.

In 1927 the United States Gypsum Co. (U.S.G.) purchased the property, which consisted of a mine and a crude wooden mill. The property was used to produce plaster and tile, for sale in the northwest. In 1936 the present boardplant was built as part of a long-range expansion program designed to provide nationwide coverage of U.S.G. products. Shortly after the board plant commenced operation, the wooden mill burned. Work began immediately to construct a new steel and concrete structure to replace the mill destroyed by fire; the new mill was complete when replacement equipment arrived from a similar plant located at Fort Dodge, Iowa. The present plant consists of a modern mine, calcining mill and boardplant, efficiently operated by approximately 120 employees.

The United States Gypsum Company and its subsidiary, the Canadian Gypsum Company, were formed in the year 1902. In the following twenty-five years the company was busy developing products for every application in the building
trade. A list of products produced will be found in Appendix I, page 50, but only those products produced at Heath will be discussed in this report.

From the beginning, the company has endeavored to produce every produce for finishing the interior as well as the exterior of the building. Constant research has advanced many of the well-known products which are produced today with unexcelled quality and constant uniformity.

**PRODUCTS PRODUCED**

*Sheetrock* is the trade name used by U.S.G. for plaster wallboard. Dry-wall construction dates back to 1895, when Augustine Sackett invented a plaster wallboard consisting of three layers of gypsum plaster sandwiched between four plies of wool-felt paper. Plaster wallboard at that time was heavy and awkward to handle, and the open edges were easily crumbled. The rough-surfaced wallboard was suitable only for use as a plaster base.

In 1910, U.S.G. discovered a simple mechanical device which would allow the edge paper of the wallboard to be turned over, completely enclosing the edges of the board. This important invention eliminated the need for layers of paper within the core of the board.

The second discovery, which led to the production of Sheetrock, was made in 1922, with the production of a lightweight foamed-gypsum core, eliminating one of the main objections to dry-wall construction: heavy, awkward sheets. Sheetrock as it is now produced is strong, lightweight, and fireproof. It is made in lengths of 6, 7, 8, 9, 10, and 12 ft
1/4, 3/8, and 1/2 in. thickness and 4 ft wide.

Rocklath is a trade name used by U.S.G. for a plaster-base board to replace woodlath. Rocklath is made in sections 4 ft long, 16 in. wide and 3/8 in. thick. The production and growth of Rocklath closely parallels Sheetrock, because the folded edge and the foamed-gypsum core were both necessary for its production. The paper used on Rocklath was not easily found, since it required a special porous finish to provide proper bond with gypsum plaster. Many builders prefer to use perforated Rocklath, which is conventional Rocklath with 3/4-in. holes punched on 3 1/2-in. centers. A mechanical fastener is obtained when the applied plaster is pushed through the holes; thus two bonds are obtained between the Rocklath and the plaster.

Wall Plaster is calcined ground gypsum with agents added to reduce drying time. Gypsum used for plaster is extra-fine ground in a tube mill to produce a product lighter in weight, with better working qualities, plus more economy. It is interesting to note that since the standard 100-lb cloth bags would not hold the increased quantity of tube milled plaster, a red strip was sewn on the existing bags to enlarge their capacity and at the same time to distinguish the new products. In this manner, U.S.G. obtained the trade mark "Red Top" for use with plasters.

In many cases wall plasters are furnished with wood chips or fibers to produce a lighter, strong plaster. The fibered plasters are made from the same gypsum as standard
wallplaster, using the same retarders as standard plaster.
The amount of retarder used in the plaster is determined in
the laboratory for each batch mixed.

**USG Sheathing**, sometimes called Gyplap, is a weather-
proof board, designed to replace wood shiplap in the con-
struction of housing. It is made in sheets 2½ in. wide,
1/2 in. thick and 8 ft in length. Production of sheathing
follows much the same technique as that of Sheetrock with but
two exceptions. Asphalt is added to the foamed-gypsum to
produce a rot-proof core, and an asphalt-resin paper is used
for a water-proof covering. **USG Sheathing** was immediately
recognized as an ideal product for use in low cost or tem-
porary housing, for several reasons, namely, economy, abil-
ity to withstand weather and fire, and ease of application.

**Agricultural Gypsum**, as the name implies, is a product
made to meet two vital needs. It fertilizes the soil and
softens much-used land. **Agricultural Gypsum** is fine-ground
raw gypsum: uncalcined and untreated.

**Cement-Rock Gypsum** is used in the production of cement.
After primary crushing, the rock is shipped to a cement pro-
cessing plant. Cement is not one of the products of **U.S.G.**;
however, the company sells huge quantities of gypsum rock
annually to cement companies for use as an accelerator in
their products.

**Gauging Plaster** is a special plaster of high-purity
gypsum which is mixed with finishing lime and applied over
regular wall plaster to produce a smooth finish coat.
MINING OPERATION

The mining operation at Heath is carried on underground, using the room-and-pillar method. The present mine, opened on August 8, 1951, is located about one-half mile north of the main plant (see map of plant on page 7) and is connected by an underground tunnel. The general layout for the mine will be found on page 8. A staff of seven men is required to operate the mine.

The mine is laid out in a herring-bone pattern with two main haulageways and three exits. The rooms mined are 22 ft wide and 7 ft high. Two men, using Jeffery electric drills with augers, do all of the drilling and blasting for the entire mine. To carry his tools each driller has a drill cart powered by an electric motor. The drills are post-mounted for operation.

The blasted rock is loaded into Joy shuttle cars by an electric-powered Joy loader, and then hauled to the portal of the mine. Both the shuttle cars and the Joy loader are powered by electricity, supplied through an overhead trolley system. The blasted rock ranges in size from 6 in. to 2 ft in diameter. At the portal, the rock is elevated on a pan-type conveyor to the jaw cruscher, which reduces its size to about 3 in. in diameter. The jaw cruscher used for primary reduction is a 24-by-36 inch Butterworth and Lowe Jumbo Nipper.

The crushed rock from the jaw cruscher drops on to a 24 in. belt conveyor, elevating it to the top of a 24 in. swing-hammer pulverizer, which reduces the rock size
FIG. 4 MINE LAYOUT MAP

SCALE: NONE

HAROLD L. COOLIDGE
to minus one inch. The crushing facilities are located at the mine, because the rock from the mine is delivered to the mill on a conveyor belt 2600 ft long and 18 in. wide. (see Flowsheet, Mine to Mill, Page 10). The pulverized rock, from the bottom of the swing-hammer mill, is fed on to the 2000 ft, No.-2 conveyor for the first portion of the trip to the mill building. The second conveyor, No. 3, on the trip to the mill is 800 ft long; it is located between the end of conveyor No. 2 and the mill building. The conveying system was built in 1951 to transport the rock from the new mine to the mill. The system is located underground in part of the workings of the old mine which in 1949 caved-in as a result of extensive operations.

The conveying system is constructed on a steel benchwork which connects the mine and the mill. An 18-in. 5-ply rubber belt, which carries the rock, runs on self-centering idlers to complete the system. The conveyors are powered by two electric motors, interlocked electrically, to prevent jamming should one of the conveyors stop.

The conveying system carries a load of 300 to 400 tons of rock in an 8-hr shift, running full about one half of the shift. The system was constructed large enough to accommodate any future expansions anticipated.
FIG. 5 FLOWSHEET MINE TO MILL

SCALE: NONE

HAROLD L. COOLIDGE
MILLING OPERATION

As may be seen on the map on page 7, the mill building is an L-shaped building, 144 ft long and 131 ft wide. In the mill the rock is stored, ground, calcined, and binned for boardplant and packing department use. To explain the two flow sheets which cover the mill, all equipment in the building will be discussed.

When the rock from the mine arrives at the mill bin, it is screened and separated into three size ranges: minus 1/4 in., plus 1/4 in. minus 3/4 in., and plus 3/4 in. A Link-Belt UP238 vibrating screen is used for the above separation. As may be seen on the rock bin flowsheet on page 12, by use of the elaborate ducting system the rock from any part of the separation may be placed on either belt or in either bin.

The rock received and screened is normally placed in the main rock bin, which holds 200 tons of live storage. The rock, which is plus 3/4 in., is normally placed in the cement plaster rock bin for shipment at a later date to a cement company. By separating the rock into different sizes, the rock can be fed with more uniformity to the Raymond Mill bins at a later date. The rock is extracted from the bottom of the bin with Syntron F22 vibrating feeders, which place the rock on the bin discharge belt. The discharge belt dumps into a bucket elevator, which lifts the rock to the top of the Raymond Mill bins.

The entire system is electrically interlocked to prevent jamming, should one piece of equipment break down.
FIG. 6 FLOWSHEET OF MILL BIN

SCALE: NONE

HAROLD L. COOLIDGE
Belt No. 5 was installed to by-pass the bin and go straight to the Raymond mill bins should the elevator break down and temporarily prevent the use of the bin. The 40-ton Raymond mill bins are provided to supply constant capacity to the Raymond Mills and to eliminate constant use of the elevator from the main rock bin.

Grinding of the rock is accomplished in two Raymond bowl mills with exhauster fans to remove the ground material. (See flowsheet on page 14.) The capacity of the mills depends on the size of rock fed and the fineness to which it is ground. Under normal operation the mills will grind between 2 to 10 tons per hour. The grind depends on the use of the gypsum and will normally be about minus 50 mesh, plus 100 mesh.

The exhauster fans, which remove the ground material, are regulated to obtain the desired grind. Material removed by the exhauster fans is blown through 2 ft ducting to the top of the mill building, where it is separated by Cyclone separators. To provide an enclosed system which prevents dust loss, 18 in. ducts return the cleaned air to the exhauster fans.

Ground Gypsum is called land plaster. Prior to being calcined in the kettles, the ground gypsum from the Cyclone separators is stored in 75-ton land plaster bins. When Agricultural Gypsum is packaged, the bins are by-passed and the material is dropped to the first floor, where it is transferred by conveyor No. 19 to the Bates packer.

Conveyors, numbered 4, 5, and 6, are used for
removing the land plaster from the bins and delivering it to
the two kettles for calcining. Calcining is carried out in
two kettles, which hold about 18 tons of uncalcined material.
The kettles are constructed as shown in Fig. 8 on page 16.
Firebrick and steel are used in the construction of the ket-
tles. The outer shell is 15 ft in diameter and 22 ft in
height. Fire brick forms the firebox and supports the inner
shell of the kettle. The calcining is carried on in the
inner shell, which is 10 ft in diameter and 15 ft high.
The gypsum in the kettle is stirred by rabble arms, driven
by an electric motor from the top. Drag chains are used on
the lowest rabble arm to help stir the material which is in
contact with the 1-in. convex bottom of the inner liner.
The fire box is located within the outer shell, directly be-
low the inner liner of the kettle. Heat transfer to the
gypsum in the kettle occurs through the liner bottom and
through the flue duct which runs through the center of the
kettle on the way to the flue.

To prevent damaging the brick in the firebox of the ket-
tles, a pre-heat system was installed. Under normal condi-
tions one kettle is always being operated. Heat is extracted
from the hot kettle and blown through the cold kettle to slow-
ly bring the firebrick to the flue-gas temperature of the hot
kettle. (See Fig. 9, page 16.) Hot gas for the pre-heat oper-
ation is obtained from the flue of the hot kettle and blown
through a 16-in. duct to the fire box of the cold kettle and
thence out the flue of the latter kettle.

Heavy fuel oil, No. 3, with a high sulfur content, is
used to fire the kettles. An inspiration-type burner, 5-in.
in diameter burns the oil, which is pre-heated by electric
FIG. 8 KETTLE AND HOT PIT

SCALE: NONE

HAROLD L. COOLIDGE

FIG. 9 PREHEAT EQUIPMENT ON KETTLES

SCALE: NONE

HAROLD L. COOLIDGE
strip heaters. The oil is forced into the burner under a pressure of 50 psi.

The material being calcined is placed in the inner shell and agitated by high-pressure air and by the rabble arms. The air agitation in kettle No. 1 is accomplished when air is forced through the hollow shaft and out through the lower rabble arms. Since Kettle No. 2 has a solid shaft the air line is run down the side of the inner shell. The kettle is filled with land plaster and is agitated through out the entire calcining process.

The temperature as the process starts is about $60^\circ F$, and will rise steadily to about $250^\circ F$. At $250^\circ F$ a calcining solution of dissolved calcium chloride is added by the equipment shown in Fig. 10 on page 18. One hundred pounds of pure calcium chloride is placed in the mixing tank and about 125 gal of water is added. Air agitation mixes the solution. When the solution is made, the required quantity is measured into the charging tank. Air pressure blows the solution through the charging line to the kettle. The calcium chloride, about one gallon, is added to the hot calcine to help complete the airidization.

Calcining continues until the temperature reaches $323^\circ F$, at which time the load is dumped into the hot pit. Because of its fluidity, it is very difficult to hold the hot calcine in the kettle during calcination. For this reason, a ball valve, employing a "grasshopper" linkage, is forced into a circular seat to prevent leakage of the calcine through the dumping hole in the bottom of the kettle. During the calcining
Fig. 10
AIRIDIZING SYSTEM
TRACE OF DRAWING by
HAROLD L. COOLIDGE 8-3-53
period the actual process has been the removal of 3/4 of the chemically-held water in the gypsum, leaving essentially CaSO₄·½H₂O as the end product. The entire calcining period requires 2 1/2 hours.

Stucco, as the calcine is called, remains in the hot pits until samples can be taken to determine whether it is fully calcined. While remaining in the hot pit, the stucco has a chance to cool to about 200°F., depriving it of its fluidity and making it easier to handle. A drag chain removes the stucco from the hot pit and places it in the hot pit elevator, which raises the material to the third floor. At this point, No. 8 conveyor carries the stucco to the stub elevator, which elevates the hot calcine to the fourth floor. The "west" stucco conveyor places the material in one of the board stucco bins for further use by the boardplant.

For material which must be re-calcined, a slide opened in the bottom of No. 8 conveyor allows the material to fall into No. 23 conveyor, which moves the material to the re-claim bin. The No. 23 conveyor also delivers stucco to the tube-mill bin and the gauging screen. Material which passes through the gauging screen is conveyed directly to the packing department for making special gauging plaster.

Stucco in the re-claim bin is removed by conveyor No. 24 and elevated in the tube elevator. From the tube elevator, the re-claim is dropped into the stub elevator, where it is elevated to the fourth floor, to be placed in the re-claim conveyor, No. 19. The re-claimed material is
actually put back into the land plaster bin to be re-calcined.

Tubed stucco, as material which is ground in the tube mill is called, is used for making wall plaster; because of the better working qualities of the finer ground gypsum. Material to be tubed is placed in the tube mill bin, where it can be drawn by drag chain and conveyor as needed. The stucco is normally tubed while hot; therefore the tube mill bin acts only to keep the material at a constant supply.

Eighteen tons of one and one-quarter inch steel balls form the grinding media for the 22 ft long by 2 ft-in-diameter tube mill. The tube mill revolves 21.9 rpm and is capable of grinding a maximum of 21 tons per hour. Normally about 71\(\frac{1}{2}\) tons of stucco are tubed per hour. To retain the heat in the stucco during the tubing process, 1 ft thick blocks of spun glass insulation are employed. It is interesting to note that the steel balls were placed in the mill in 1936, and to date they show no apparent sign of wear. Steel balls are selected for this operation in preference to cast iron balls because the iron balls are subject to breakage. Number 15 conveyor removes the material from the tube mill and places it in number 4 elevator, which elevates the tubed material to a forty-ton storage bin, No. 1. Later, the material will be removed to the packing department for subsequent operations.

Stucco, which is placed in the mill bins, is removed by conveyor No. 11 and run through a "scalper" screen, which removes any gummed balls resulting from the calcination. Following the "scalper" screening, the material is conveyed to the board plant stucco bin or the packing department bins for further processing.
Stucco for making Sheetrock must be at a temperature of about 100°F., therefore the stucco is not binned in the mill any longer than necessary. If the stucco in one bin becomes too cool it is mixed with hot stucco to bring the temperature up to the necessary requirements.

It is interesting to note that 6 men run the entire mill twenty four hours a day. The crew consists of a superintendent, a foreman, an oiler-inspector, and three "calciners"—one for each eight-hour shift. When one examines the mill, he discovers that material in any bin in the mill can be conveyed to any other bin. Careful engineering has made the mill one of the most efficient ever designed. The mill, at present, handles about three hundred and fifty tons of material per day and could handle upward to 600 tons per day if future expansion required it.
BOARD PLANT

The board mill is located in the board plant building which is 560 feet long and 60 feet wide. The board plant building also contains space for the office, laboratory and packing department. The actual production of Sheetrock, Rocklath and Sheathing is accomplished on the second floor of the building, in bays 4C to 28C inclusive (see diagram of board-plant on page 23). Storage space for finished products is found in bays 4A to 21A and 4B to 21B inclusive. The kiln is located below the board machine between bays 10C and 22C.

Stucco, which is used in the fabrication of board materials, is delivered to the minty-ton board stucco bin by the belt conveyor from the mill. A drag chain is used to remove the stucco from the bottom of the board stucco bin and place it in a spiral conveyor which conveys the material to the board stucco elevator. Stucco, elevated by the elevator, is placed in a conveyor which conveys the material back to the top of the board stucco bin. In the bottom of the stucco conveyor, which is returning to the board bin is located a 4-inch vertical tube which allows the stucco to drop to the metering screw. (Fig. 12, page 24)

The metering screw is a triple-flight enclosed screw conveyor used to control the amount of gypsum stucco which is delivered to the primary mixer. The vertical drop tube which feeds into the metering screw is used to provide a constant head of stucco. Stucco is constantly circulated through the conveyor-elevator system and back to the bin at the rate of about one and one-half times the capacity of the
FIG. II BOARD PLANT LAYOUT

SCALE: 1" = 80'

HAROLD L. COOLIDGE
FIG. 12 FLOWSHEET OF BOARD STUCCO

SCALE: NONE

HAROLD L. COOLIDGE
metering screw; thus assuring complete capacity of the metering screw at all times.

The stucco is dropped from the metering screw into a 30-foot double-flight conveyor which carried the material to the vertical screw. The vertical screw is used to assure a more uniform feed of stucco to the primary mixer.

Several other materials are added to the mixer besides the stucco, to make foamed-gypsum core of Sheetrock, Rocklath and Sheathing. Among these materials are paper fibre, water, starch and two setting re-agents. The names of the setting re-agents are not available for use in this report because of company regulations.

Water is one of the most important factors in the making of foamed-core gypsum board. Not only must water be available in adequate quantity, but it must be chemically free of virtually all carbonates. The water used at Heath is pumped by jet-type pumps from shallow wells and piped to a storage tank on the hill overlooking the plant. Storage facilities at Heath are limited to a 75,000 gallon water tank, of which only 25,000 gallons are available for production. 50,000 gallons of water are left in the tank at all times to assure adequate fire protection.

Water consumed by the mixer varies from 25 to 40 gallons per minute, depending on the thickness of the board being produced. A rotometer is used to supply the water to the mixer since manual control for this sensitive operation would be virtually impossible. The amount of water used is very critical; too much and the board will not set up before leaving the belt line; too little and the stucco
will set up before the board is fully formed.

Another of the important components of the foamed-gypsum core is the paper fibre. The fibre is used to provide a stronger, lighter core and is produced at the mill. The paper which is used for the production of Sheetrock and Rocklath is not made at Heath but is shipped in from another company plant located at Genoa, Ohio. The paper is made about one and one-third feet wider than is required for producing Sheetrock and Rocklath. After the paper is rolled into one and one-half ton rolls, the excess is sheared off and shipped to the plants making wallboard, for the production of paper fibre.

Paper fibre is made by running the waste paper through a swing-hammer mill which runs at a rate of 3600 revolutions per minute. When the paper is fiberized, a fan blows the fibre to a storage bin for later use. Another metering screw is used to feed the fibre into the conveyor which carries the stucco to the mixer. The reason for mixing the fibre into the dry stucco is to allow time for mixing before the water is added; thus preventing matting of wet paper.

Re-agents are the fourth class of materials added to the mixer. In the re-agents class there are three solutions added. The first re-agent is a starch solution. Powdered starch is added to water and cooked in a boiler. From the boiler, the starch is placed into a cup feeder which ladles the material into a pipe that runs to the mixer. The two setting re-agents are also fed to the mixer by cup feeders. The three cup feeders are run by a single motor to provide a proportionate feed at all times.
The starch is added to the foamed-gypsum core to keep the foam stiff until the core is set up. The other reagents are added to accelerate the setting of the gypsum.

Stucco is mixed with the fibre, water, and setting reagents in the primary mixer before being dumped into the secondary mixer. The primary mixer is located above the secondary mixer and is driven by a separate motor. Mixing, in the primary mixer, is accomplished by revolving arms which turn inside the twenty-four-inch-in-diameter by five-inch-in-height case. The primary mixer is used to accomplish complete mixing of the constituents being dumped into the secondary mixer.

Secondary mixing is actually the process of beating the mixed product, from the primary mixer, into a foam. Construction of the secondary mixer is more complicated than the primary mixer and the drawing on page 28 will explain the machinery.

The material, which has been mixed in the primary mixer (Fig. 13A), is dumped into the secondary mixer through a hole (Fig. 13B) which is located in the top of the secondary mixer case (Fig. 13F). Upon entering the case, the mixture falls onto the mixer ring (Fig. 13G), which is a cast iron plate about four feet in diameter. The mixer ring is cone-shaped in the center to spread the mix toward the edge of the case. This ring has a series of raised "kickers" toward the outer edge which are used to raise the mixer balls (Fig. 13D). When the cover ring (Fig. 13E) which has a series of baffles within, is revolved, the mixing balls are rotated around the mixer ring.
CROSS SECTION - SIDE VIEW

CROSS SECTION - TOP VIEW

A - PRIMARY MIXER
B - ENTRANCE TO SECONDARY MIXER
C - RUBBER BOOTS
D - MIXER BALLS
E' - COVER RING
F - SECONDARY MIXER CASE
G - MIXER RING

FIG. 13 MIXER CONSTRUCTION

SCALE: NONE

HAROLD L. COOLIDGE
The mixing balls are rotated around the mixer ring. The mixing balls are four-inch lead-impregnated rubber balls and are used to beat the stucco mixture into a foam.

As the stucco mixture travels toward the outer edge of the case, it is trapped in the cover ring where it is mixed. As the stucco travels around in the cover ring it is dropped through the rubber boots (Fig. 13C) on the bottom of the mixer ring, to the paper below. The rubber boots are three inches wide by eight inches long and seven inches deep and are used to provide directional flow of the mixture on the paper which is traveling below.

Two sheets of paper are used for the production of Sheetrock. The paper used for the face of the Sheetrock is a manila-faced paper, 51 inches wide and comes in rolls weighing approximately one and one-half tons. The backing paper comes in rolls of the same weight and is about 47 3/4 inches wide. The backing paper is not faced with a manila covering.

The face sheet of paper is placed on roll number one (Fig. 14, page 30) in such a manner that the manila facing will be down when the paper travels under the mixer. Sheetrock is normally made 48 inches wide. The extra three inches of width in the facing paper is used to make the folded edge on the board. Scoring saws are used to cut the paper about half way through to insure a square corner on the folded edge.

The scoring devices are two small saws, four inches in diameter, mounted on a motor. Three sets of saws are used, one pair at a time, depending on the thickness of the
**FIG. 14** PAPER FEED (SHEETROCK)

SCALE: NONE

HAROLD L. COolidge

**FIG. 15** SCORING DEVICE

SCALE: NONE

HAROLD L. COolidge
Sheetrock to be made. Figure number 15 on page 30 will explain the actual of the scoring devices. The inner saw blades are always mounted 48 inches apart; the spacing of blades on the device depends on the thickness of the board being produced.

As the facing paper passes under the mixer (Fig. 16, page 32) the mix is dropped onto it. Next, the folded edge is placed on the paper and the upper paper and mix is advanced to the variable rolls which determine the thickness of the Sheetrock. At this point the backing paper from roll number 2 (Fig. 14) is applied to the Sheetrock, sealing the foamed-gypsum core between them. Glue is applied to the edge of the backing paper, as it passes over the variable roll, to seal the front and back sheets together at the edge.

After leaving the variable rolls, the wet wallboard travels on a rubber belt for a distance of about two hundred feet. The purpose of the live-rubber belt is to support the Sheetrock until the core is set up. Provisions are made on the first portion of the belt to hold the sides of the board square. The belt travels 38 feet per minute for one-half inch Sheetrock, 49 feet per minute for three-eighths inch Sheetrock and 60 feet per minute for one-quarter inch Sheetrock. The setting time for the core is normally about one and one-half to two minutes.

Live-rubber belting, fifty inches wide and three-quarters of an inch thick, is used for the belt portion of the production line. Half-cured belting is placed on the line and run for several days to remove the ripples which result from shipping. The heat from the drying Sheetrock is used
FIG. 16 FLOWSHEET - MIXER THROUGH KILN

SCALE: NONE

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to finish curing the belt. The process of curing takes several months. If necessary the belt is sanded to remove ripples which will not stretch out upon running.

Plastic tapes, three inches wide and one-thirty-second of an inch thick are placed on the edge of the rubber belt line to create the indented edge on the Sheetrock. This edge is generally, though not always, placed on Sheetrock to provide a place for the Perf-a-tape jointing system.

Following the rubber belt part of the production line, the Sheetrock, which is now hardened, travels on rollers for a distance of about forty feet. The Sheetrock passes under the wet punch, which is used only for perforated Rocklath, and proceeds to the revolving shears. When the end of the Sheetrock hits a solonoid, which sets the revolving shears in motion, the wall board is cut to a pre-set length.

A high-speed roll section, which travels twice the speed of the belt line, twenty feet long follows the shears. Rapid movement is necessary at this point to remove the cut pieces to the inverter before the next piece is sheared.

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FIG. 17 INVERTER

SCALE: NONE

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Inverting The Sheetrock is necessary because the face paper is down and should not be placed in the kiln in this position, because to do so may risk soiling the manila covering. The inverter, which is shown in Figure 17, page 33, consists of a metal frame which is rotated on its' axis A, A', a series of continuous belts (B), and a rotating mechanism. When the cut board enters the belts, which are spring-mounted to grip the Sheetrock, they momentarily stop and the inverter turns over. Rotation of the belts again starts and the Sheetrock exits from the bottom of the inverter on to the second high-speed roller section.

It is not necessary to invert Rocklath; therefore, when it is being produced, the high-speed roller section, following the inverter, is raised to allow the Rocklath to pass through the inverter without being inverted.

The second high-speed section is about twenty feet long, and is used to remove the board quickly from the inverter. Following the second high-speed section is a set of inclined rollers which travel the same speed as the belt line. The inclined section is used to move the Sheetrock to the first floor for kiln drying. After traveling down the inclined rollers, the direction of flow is reversed by the reversing rolls and the Sheetrock is placed on the tilting table for feeding to the kiln. (See Fig. 18, page 35)

It is desired that the drying speed in the kiln be one-eighth the speed of the board line. The kiln is therefore constructed with eight decks. A tilting table is used to feed the eight decks of the kiln. The decks are filled in the order of 1, 3, 5, 7, 8, 6, 4, 2, 1, 3 and continued in
FIG. 16 TILTING TABLE AND REVERSING SECTION

SCALE: NONE

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that order. The tilting table is operated by a solonoid which is released when the Sheetrock entering the kiln leaves the table.

The belt line, roller sections and kiln are all driven by a line shaft which is powered by a one-hundred horsepower electric motor. A Reeves variable-speed drive is used to accomplish speed changes on the line. With the use of a line shaft no adjustment is necessary to keep the board line and kiln operating without jamming.

The kiln is used to dry the wet Sheetrock. A double tile wall is used for the construction of the kiln with the eight decks of rollers mounted on a steel rack inside the inner wall. (Fig. 19, page 37) The rack which supports the rollers is not connected to the inner tile wall, thus allowing for the difference in expansion and contraction of the tile and the steel. The entire steel deck is mounted on bearing plates to allow for expansion when the heat of 200 degrees is applied. The rollers in the kiln are driven by a continuous chain on each deck. The chains have a tightener on one end to allow for expansion and contraction.

The kiln is heated with forced hot air. Two oil-burning furnaces heat the air which is forced into the 240 foot kiln by a 200 horsepower blower. The heated air enters the kiln near the center and is deflected toward both ends.

Exhauster fans are located at each end of the kiln to extract the wet gases. Because of the wet air it is impossible to return the warm air to the main blower for re-circulation. Baffles are placed at each end of the kiln to prevent the escape of hot air from the end of the kiln.
FIG. 19 KILN

SCALE: NONE

HAROLD L. COOLIDGE
At the dry end of the kiln, the Sheetrock is removed from the eight decks and placed on a table which saws the ends of the board smooth. Two pieces of Sheetrock are laid face to face and the ends taped, ready for either shipment or storage in the warehouse.

The production of Rocklath varies only slightly from the production of Sheetrock. Three rows of Rocklath are produced simultaneously on the same belt line. Scoring is not required for the production of Rocklath because the edge is left rounded. Rocklath requires a different paper than Sheetrock also, because a bond with plaster is necessary.

Paper feeding to the machine also differs when making Rocklath (Fig. 20, page 39) due to the fact that three separate pieces are made, instead of just one as with Sheetrock. The bottom paper is eighteen inches wide and the top paper is fifteen and three-quarter inches wide. Paper feeding is accomplished by placing one thirty-six inch roll in position one, one eighteen inch roll in position two and one forty seven and one-fourth inch roll in position three. The paper from roll number one is cut into two eighteen-inch strips and fed to the outer boots of the mixer. Number two roll is fed to the center boot of the mixer. The top paper from roll number three is cut into three strips and fed in the same manner as for Sheetrock.

When making Rocklath the rotary shears are placed in continuous operation. Since Rocklath is made in four foot lengths, the shears are run on cams, cutting the board off every other time, and only perforating the paper on odd strokes. This leaves the Rocklath being fed into the kiln
FIG. 20 PAPER FEED (ROCKLATH)

SCALE: NONE

HAROLD L. COolidGE
in eight foot lengths and prevents jamming of the tilting table.

At the take-off end of the kiln the eight foot pieces are broken along the perforation and bundled, five or six sheets to the bundle. "U"-shaped metal clips are used to fasten the bundle together.

The production of Sheathing varies only slightly from the production of Sheetrock. The paper used for Sheathing is asphalt-impregnated and comes in rolls twenty four and twenty six inches wide. Two twenty-six-inch rolls are placed on the bottom paper feed and the two twenty-four-inch rolls are placed on the upper feed. The center boot is closed on the mixing machine because only two strips are being produced, each being two feet in width.

The main difference in the production of Sheathing is the fact that asphalt is also added to the mixer to make a water-proof core. Asphalt is added to the mixer at the rate of about eighteen gallons per minute. The rest of the process is identical to that of Sheetrock, with the exception of the scoring and folding of the edge paper. Sheathing is produced only in one-half inch thickness. The edge of Sheathing is tongued and grooved, thus making it necessary to score the facing sheet five-eighths of an inch wide on both edges; the inner grooves being twenty four inches apart.

Shipping of wallboards which are produced at Heath, as well as those which are produced at other U.S.G. plants and shipped to Heath for re-distribution within the distributing area of the plant, is accomplished by both railroad and the truck lines. About fifty percent of the boards are shipped
by truck lines which operate in the states of Montana, Wyoming and Idaho. The remaining fifty percent are shipped by railroad. All boards are handled by fork-lift trucks.

Sheetrock is normally shipped on special flat cars which built by the railroad for U.S.G. Shipments. The specially-built cars are forty feet long and have built up ends which are braced to prevent the load from shifting. After the Sheetrock is loaded, a hydraulic press is used to pack it and a frame is built to hold the load stationary. To prevent damage caused by the weather, the car is covered with asphalt paper.

Rocklath is shipped in box cars, due to the fact that the short lengths would be difficult to bind down on a flat car. Sheathing is normally shipped on a flat car in the same manner as Sheetrock.

The order in which the boards are to be placed on the car is determined by the packing clerk in the plant office. The packing clerk provides the packing chief with a diagram, to assist him with the proper placement of boards, in order that the maximum finished product can be shipped with a minimum of damage.
PACKING DEPARTMENT

The packing department is located in the northwest corner of the board plant building in bays 1A to 4A and 1B to 4B inclusive. (Fig. 11, page 23) Packaging of all types of plasters is performed in the packing department. Four types of plaster are mixed and packaged at Heath: standard wall plaster, fibred wall plaster, wood-chip wall plaster and gauging plaster; all sold under the trade name of "Red Top". A twoman crew, one of whom does the mixing of the various plasters and the other who performs the packaging duties, operate the department. Upwards of one hundred and fifty tons of various types of plaster are packaged in one-hundred-pound bags daily. These same two men also perform the task of packaging the agricultural gypsum in the mill.

All of the stucco which is used by the packing department, with the exception of gauging plaster, is tubed. The stucco is delivered to the packing department by the same equipment which delivers stucco to the board plant. When tubed stucco is being conveyed to the packing department, the board storage bin is by-passed and the material is delivered by conveyors number 20 and 21 (Fig. 7, page 14) to the three packing department bins.

Conveyor number 22 is used to remove the stucco from the packing department bins and to deliver it to the one-ton weighing hopper. Normally, about eighteen hundred pounds of tubed stucco are placed in the weighing hopper. The hopper is electrically operated to weigh the stucco, turning off the conveyors automatically when the pre-
determined amount of material has entered the hopper.

All plasters, packaged in the packing department are weighed in this hopper. Into this hopper, containing tubed stucco, are added the retarders and re-agents which are necessary to make the various types of plaster. All of this material is then dumped into a Broughton one-ton mixer, where it is thoroughly mixed before being dumped into the Bates packer. The Bates packer used for this operation is a four-spout forced-fed machine which automatically fills the bags with one hundred pounds of material. The bags used for the packaging are of the self-sealing, valve-type variety.

The materials used for the production of standard wall plaster are as follows: eighteen hundred pounds of tubed stucco and four pounds of retarder. The retarder used in producing wall plasters is made from animal hides, hair and hooves which are dried and finely ground.

The ingredients used to produce fibred wall plaster are the same as for standard wall plaster with these additional ingredients: five and one-half pounds of alum, nine pounds of line, three and one-half pounds of flour and one pound of ground horse hair.

Wood-chip plaster is identical to fibred plaster with one exception: twenty-five pounds of wood chips replace the horsehair in the mixture.

Gauging plaster is produced by using eighteen hundred pounds of special-gauged stucco, which has not be tubed, and four pounds of retarder.

In addition to the plasters produced at Heath, several
other types of plaster which are not produced locally, but which are shipped in from other U.S.G. plants, are stored in the packing department, prior to local distribution.

Materials shipped from the packing department are handled by the same transportation systems as those which handle the products from the board plant. Similarly, the packing clerk provides a packing diagram for placement of the finished products in the box cars to the packer in this department.
QUALITY DEPARTMENT

The quality department is located in the northeast corner of the board plant building, in bays 2C to 4C, (Fig. 11, page 23). The quality department is responsible for testing all materials produced at Heath to insure highest quality and uniformity of the products.

The personnel of the department is comprised of a quality superintendent, who is a graduate engineer thoroughly familiar with chemistry, and six men, called "testers", who do the actual testing. The testing methods, employed by the testers, are strictly mechanical for two reasons; first, the testers do not have backgrounds in chemistry, and second, the number of samples tested each day are too numerous to employ chemical analysis. Materials tested include; mine-face samples, screen analysis on ground gypsum from the Raymond and tube mills, stucco from the kettle for complete airidization, stucco from the secondary mixer, and plasters from the packing department as well as board produced.

Screen analysis is preformed in a multiple screen shaker on all Raymond mill and tube mill products to assure constant uniformity of grind.

In the laboratory, samples are tested for setting time on both plasters and board stucco, to determine the amount of retarders and accelerators which are to be added, to produce a product of uniform quality. To perform this test, one hundred grams of stucco or plaster are thoroughly mixed with one hundred cubic centimeters of water and poured out onto a waxed paper from a given height. The diameter to
which this mixture spreads on the waxed paper is recorded.
To test the setting time, a weighted rod, with a ground tip,
one-sixteenth inch in diameter, is gently lowered on to the
mixture and the moment at which this rod fails to penetrate
the material is called the setting time. Purity of the gyp-
sum product is determined by comparing the diameter spread
with the setting time of the material. This is accomplished
with the aid of charts designed for this purpose.

Board products made at the plant are tested for tensile
strength, thickness and quality of the paper covering. Sam-
ples of all boards produced are taken at regular intervals
for these tests.

To test for tensile strength, nine pieces measuring two
inches by eight inches in size are cut from the board samples
in a pre-determined pattern. The pieces are broken by the
tensile-testing machine to determine the strength. Should
the board fail to meet required standards, it is scrapped as
"dunnage" and used for lining shipping cars. Rocklath is
tested for bonding of the paper as well as for tensile
strength. Wet plaster is applied to the Rocklath to deter-
mine the bonding quality. The paper on Rocklath has the
quality of absorbing the water from the plaster. If the
absorption rate is too great the plaster will crack; if it
is too slow the plaster will not bond properly.
The engineering department is responsible for the installation and repair of all equipment and buildings on the premises. Personnel in this department includes two graduates engineers and a maintenance crew of approximately twenty men. When it is deemed necessary, assistant engineers are sent into the plant from the general office, located in Chicago, Illinois, to assist in details of design and installation of projects, too large or too complicated to be handled by the local staff.

The maintenance crew build, install and repair virtually all equipment and buildings. A large modern shop, equipped with all necessary tools and machinery for fabrication and repair, is provided. The minor repair and maintenance jobs throughout the plant are performed by the oiler-inspectors in each division. The plant engineer is responsible for ordering any repair parts which cannot be designed and built on the premises. He is also responsible for the constant supervision of all repairs and must anticipate repair jobs which cannot be done during normal operation; in order that these major repairs can be done during a shut-down period, which is scheduled for one eight hour shift per week.
PLANT OFFICE

A small office staff of six men is responsible for keeping all plant records. Employees in the office include a Personnel Superintendent, an Office Superintendent, a cost clerk, a packing clerk, a buying clerk, and a chief clerk.

The duty of the Personnel Superintendent is the procurement of personnel and the maintenance of plant safety. The Office Superintendent oversees the office staff and assures swift action on all correspondence. The cost clerk keeps records of all material bought and sold and is responsible for invoicing all outgoing materials. The packing clerk designs the loading diagram for all materials being shipped from the plant; he is responsible for proper loading procedures to prevent damage. The duties of the buying clerk include the procurement of all parts and material used or carried by the plant for resale. The chief clerk assists all other clerks in their duties. The men employed as clerks are rotated at regular intervals to all of the various clerking jobs, to acquire knowledge of all of the duties of every other clerk. This procedure is followed to prevent the office from being "caught" short-handed at any time.

Each of the department superintendents is responsible to the Works Manager. The duty of the Works Manager is to assure the smooth, efficient operation of the entire plant.
Employees at Heath are not affiliated with any labor union; all labor-management problems are handled by a grievance committee, consisting of an elected representative from each department, and the Works Manager. The committee meets bi-weekly to study all grievances and problems and negotiate an agreement satisfactory to both the employees and the company.

The Heath Plant is run in a very efficient manner, utilizing the latest in modern machinery and methods. The plant is under the supervision of a competent engineering staff who guide the operation. The 120 men at the plant produce approximately 266,000 sq ft of Sheetrock, and approximately 100 tons of plaster per day.
APPENDIX I

PRODUCTS OF U. S. GYPSUM

* Sheetrock
* Rocklath
* Sheathing
* Plaster
* Fibered Plaster
* Wood Chip Plaster
* Agricultural Gypsum
* Gauging Plaster
* Cement Rock Gypsum
Pyrobar
Short Span Roof Tile
Gypsum Finish
Bondcrete
Pottery Plaster
Gypsum Lath Clip System
Long Span Roof Tile
Crayon Plaster
Aluminum Foil-backed Sheetrock
Woodgrained Sheetrock
Perf-a-tape System
Acoustic Stone Tile
U.S.G. Expanded Metal
U.S.G. Diamond Mesh Metal Lath
Hydrocal
Metal Roof Deck
Weatherwood
Texolite Paint
Sesilient Clip System
Red Top Mineral Wool
Tongue and Groove Roof Plank
Asbestos Cement Siding
Glatex Siding
Finishing Lime
Asphalt Shingles
Roofing Felt
Patching Plaster
Spackling Putty
Textone
Plaster of Paris
Dental Plaster
Sheetrock Sealer
Finishing Plaster

* Products produced at Heath Plant