Chapter Seven
Constructing the Rock Bin

Introduction

This chapter on how to construct a rock bin is for those systems that will need remote storage. These are the systems whose collector areas are too large to be connected directly to the living space. If the collector is too large, it produces more heat than the living space can use. This excess heat can be carried to a storage bin, stored in the mass of the rocks, and later retrieved when it is needed.

Most rock bins are built with a duct opening at the top and a duct opening at the bottom. Hot air from the collector is introduced at the top, forced down through the rocks and out the bottom. The MODEL-TEA rock bin differs from these because the duct openings are both at the top. A center partition with an air space below it allows the air to enter at the top duct opening on one side, pass down through the rocks, slip under the partition, and pass up through the rocks on the other side. The U-shaped Rock Bin coined its name from the U-shaped air flow pattern (See Fig. 7.1).

The U-shaped rock bin is divided into two equal halves by the center partition or "divider," and there is one duct opening on each side of the divider. The side connected to the return duct from the collector is called the "hot side," because the rocks on this side receive the heat first and will be the first

to warm up. The side connected to the supply duct to the collector is called the cold side. The rocks here stay cold until the rocks on the hot side have stored all the heat they can, at which time the heat in the air is carried to the cold side of the rock bin and begins heating these rocks.

The Rock Bin

The U-shaped rock bin is divided into three parts vertically: the rocks themselves, and two air plenums. The first air plenum is above the rocks, where the air enters from the duct. The air fills the whole plenum first and then begins to move down through the rocks. The rocks rest on a row of concrete bond blocks, which form the second plenum. The concrete bond blocks have a special core that when placed perpendicular to the center divider, guide the air under the rocks, under the divider and into the plenum under the other side of rocks.

Add the two plenums and the cover to the height of the rocks, and the rock bin is only 6'-6" high, low enough to fit into most basements. This was why the rock height was limited to 3'-8", so that the rock bin would be suitable for new or retrofit construction.

The instructions on how to build the U-shaped Rock Bin are meant for those persons familiar with wood-frame construction--skilled contractors, carpenters, or owner-builders. The key word is skill--the ability to perform the tasks, based on working knowledge gained from carpentry experience. The more experience, the easier these instructions will be to follow.

This chapter, plus Chapter Five or Chapter Six on Constructing the MODEL-TEA Collector, and Chapter Eight on the MODEL-TEA System Control Wiring should all be read through thoroughly. This should be done before beginning to order materials and before beginning any steps of construction.

The experienced carpenter will have most of the tools necessary to build this storage bin, but may have to borrow or rent a few of the more special ones. Among the tools needed are:

hammers, screwdrivers, tapes, pliers, tin snips, etc.
chalk line, caulking gun
hand saws, circular saw, table saw, sabre saw
power screwdriver or variable speed/ reversible drill
power actuated setting device

The following instructions are directed towards new construction applications, but there are indented sections if there are <u>additional</u> special instructions for retrofit situations.

<u>RETROFIT</u>: The instructions for retrofit will begin with the word <u>RETROFIT</u> and are indented to set them apart from the normal instructions. These indented sections <u>must</u> be read by those who are retrofitting the rock bin, and can be

skipped by those building into new construction.

Before constructing the rock bin, certain calculations must be done and decisions must be reached. First, the rock bin must be sized according to the square footage of the collector. Table 4.1 in Chapter 4 gives cubic feet of rock figures for square feet of the collector figures. Choose the proper collector square foot figure, and find the cubic feet of rock needed to store the energy from the collector.

Due to height limitations of the rock bin in typical basement construction, the actual height of the rocks in the bin is limited to 3 ft. 8 inches. Divide the cubic feet of rock by 3.67, to determine the square feet of floor area of the rock. In specific site conditions, the length and width of the rock bin can vary to best fit in a certain location. The actual width and length of the bin must include the thicknesses of the walls in addition to the width or length of rocks. By deciding the best rock dimension in one direction, and dividing it into the square foot area of rock, the rock dimension in the other direction can be found.

There will be two ducts entering the rock bin, and the square foot area of the rocks must be divided equally between them by a 2x4 (nominal) vertical wall with plywood on both sides. This wall must also be added into the width or length of the rock bin. Use the following two formulas to calculate the length of the walls parallel with the center partition (the "parallel walls") and the walls perpendicular to the center partition (the "perpendicular walls"):

"Parallel Walls" = width in ft. of rock + 1'-1 3/4"

"Perpendicular Walls" = length in ft. of rock + 1'-1 3/4" + 4-1/2"

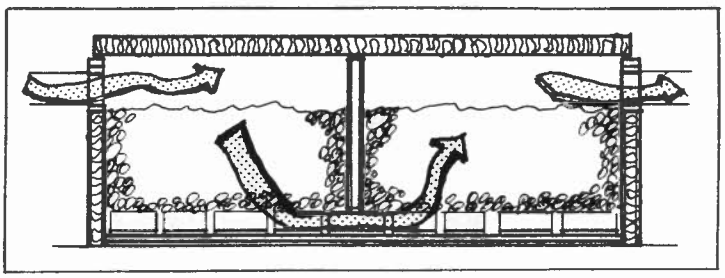


Figure 7.1 Air Flow Through a U-Shaped Rock Bin

Choose the spot for the rock bin, and plan out where the ducts will run. Choose the side that will receive hot air from the collector and which side will be sending the cool air back to the collector. Label the "hot side" and "cold side" of the rock bin on the drawings. Write in the actual dimensions of the rock bin arrived at above.

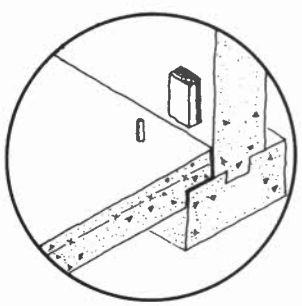
Go through the drawings step-by-step with the instructions until everything is clear. The drawings are not meant to be used without the instructions, nor are the instructions meant to be used without the drawings. Make notes on the drawings of those things that depend on site conditions. Determine how much of each material needs to be ordered, and order through the manufacturers found in Appendix A.2. Read through the materials descriptions in Appendix A.1. Such things as which type of caulk should be used with which type of joint are discussed there.

NOTE: It will be easier to load the rock bin with the rock, and to place and fasten the cover, if the floor framing is not begun until after the rock bin is complete. It is possible (as in retrofit) to construct the bin with the floor already in place, but it is more difficult.

Cover the rock bin with a sheet of 6 mil polyethylene when work is not being conducted on it. This will keep it dry until the building is closed in around it.

The following step-by-step instructions are keyed to the construction drawings at the end of the chapter. Each construction step has a key number, and a corresponding key sketch in the margin where the step begins. Each construction step has a corresponding drawing with the same key number and the same key sketch in the upper right hand drawing of the page.

As you read each section, you will be asked to refer to details on the construction drawings. For example, you might see (4-B6) at the end of a sentence. This would mean, refer to Detail 4, on Bin drawing number 6. Turn to Bin drawing number 6, and you will see a number 6 in the upper right hand corner with the word "BIN" below it. The key sketch is there, as well as the title of the page and the step: BRACING AND LOADING. As you refer back and forth from instructions to drawings, look for these four things: the drawing number, the word BIN, the key sketch and the title of the page. It is important that the instructions and the drawings are used together.



7.1 Building Preparation

This section deals with locating the rock bin, and preparing the floor and walls to receive it. The location of the rock bin, and its relationship to the collector and the living space is an important step in good system design. Structurally, the building must be able to bear the load of the rocks, which will exert a tremendous load on its walls and on

the floor slab. The rock bin must be built on a slab, because normal framing could never carry the load.

The rock bin should be located in a clear space big enough for the bin, with a clear area from eight to ten feet to one side of it. This space will be for the duct entry into the box and for the air handler and duct connections to it. The bin should be located so that duct runs from the collector and duct runs for air delivery to the living space are as short as possible. This will help cut down on heat losses.

If the storage bin is placed against a foundation wall, or better yet in a corner, the number of slab anchor bolts and temporary bracing required for rock loading can be cut down.

RETROFIT: All the above apply to retrofit applications. In addition, place the bin in a spot that stays dry year round. Moisture could rot the wood in the bin, as well as decrease the performance of the system.

The spot where the bin is located should have first floor joists high enough off the floor that would allow someone to crawl over the top of the bin later. The area should be clear of low ductwork and piping.

Last, bear in mind where and how the rocks will be coming into the basement. If possible, try to minimize the distance between the point of entry and the rock bin. This will help save on time and labor.

SLAB: The concrete floor slab under the rock bin, and 6 in. beyond its perimeter, should be 6 in. thick with 6x6x10 woven wire mesh at a level 2 in. down from its surface.

ANCHOR BOLTS: Anchor bolts will be used along any walls that are "freestanding," or not beside the foundation walls. These walls will be called "Bolt Walls." The anchor bolts will help hold the walls

against spreading under the load of the rocks. The 1/2 in. by 8 in. bolts will be located 3 in. back from the exterior faces of the rock bin.

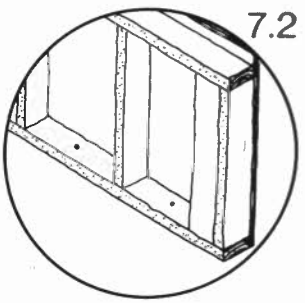
Beginning with the walls perpendicular to the foundation walls, measure out a distance from the foundation wall equal to the rock bin width or length minus 1 in. (1-B1). Place the bolts at 2'-0" on center, moving back towards the foundation wall, with the last one 5 in. from the wall. Leave 2-1/2 in. of the bolts exposed above the slab (2-B1).

If the wall is parallel to the foundation wall, but freestanding, place the bolts for the other two walls first, in lines that are the distance apart equal to the rock bin width or length minus 6 inches. Then, at 2'-0" on center, place a line of anchor bolts from one existing line to the other. These bolts should be at a distance from the foundation wall equal to the rock bin length or width minus 1 inch.

RETROFIT: If the basement already has a slab, but is not 6 in. thick, pour another layer of concrete with wire mesh reinforcing, until it is a total of 6 in. minimum. Instead of using anchor bolts, shoot the shoe plates of the walls into the slab with powder driven 1/4 in. x 3-7/16 in. pins at 2'-0" on center.

SPACERS: Blocking will be used to brace the walls that stand next to the foundation walls against spreading under the load of the rocks (1-B1). These 2x4 (nominal) by 6 in. spacers should be treated with a wood preservative. Shoot them at 16 in. on center into the foundation wall in two rows, with powder driven 1/4 in. x 3-7/16 in. pins. Place a 1/2 in. liner of rigid insulation between each spacer and the wall. The insulation will keep the wood out of direct contact with moisture in the concrete. Fasten the spacers with the top of the higher row at 6'-0" off the slab, and the top of the lower row at 6-3/4 in. off the slab (2-B1). These walls that will stand next to foundation walls will be called "spacer walls."

7.2 Panels



The rock bin will be built out of panels that are prefabricated and then tipped up into place. They are built according to normal wood-frame practices with a few minor changes. The rock bin frame has six parts - four outside walls, a center partition, and a cover. The outside walls, or panels, are constructed in this section.

The rock bin walls will be built out of 2x6 (nominal) studs at 24 in. on center and sheathed on the outside with 1/2 in. CDX plywood. The panels should be framed with double studs in one corner, and a single stud at the other end, 6 in. from the end of the plywood (1-B2). This arrangement will allow for easy fastening of the panels from the inside, once the four "panels" are assembled. The shoe and the first top plates will run from the outside of the double stud to the outside of the single stud. The panels will be 6'-0" high and their length will be the box width or length minus 1/2 inch. Frame the top plate 1-1/2 in. down from the top of the plywood (3, 4-B2).

Any walls that are "bolt walls" will be framed across the shoe plate with framing hangers, with the outside of the hanger between the stud and the plywood. This will help keep the studs from sliding on the shoe plate under the load of the rocks (4-B2; Panels C and D, 1-B2). Mark where the anchor bolts will be on the "bolt wall" shoe plate, and drill holes for the anchor bolts.

Where the duct openings will be, and in which walls, will depend on actual site conditions. But wherever they are located, the square foot area of the rock bin must be divided equally between them. This center partition will be called the "divider," a 2x4 (nominal) stud wall that will frame between the two duct openings (see Fig. 7.2). The two walls that the center divider is perpendicular to, and fastens into, will from here on be referred to as the "perpendicular walls." The two walls the center divider runs parallel with will be referred to as the "parallel walls."

At the center-line of the two panels perpendicular to the center divider, frame a 2x6 (nominal) with its 5-1/2 in. face flush with the inner wall face, and a 2x6 (nominal) ripped to 4 in. perpendicular to its center-line (Panels A and C, 1-B2). Edge-nail the 2x6 (nominal) to the 2x4 (nominal) with 16d nails at 16 in. on center. End-nail the plates to the two studs with four 16d nails at each end.

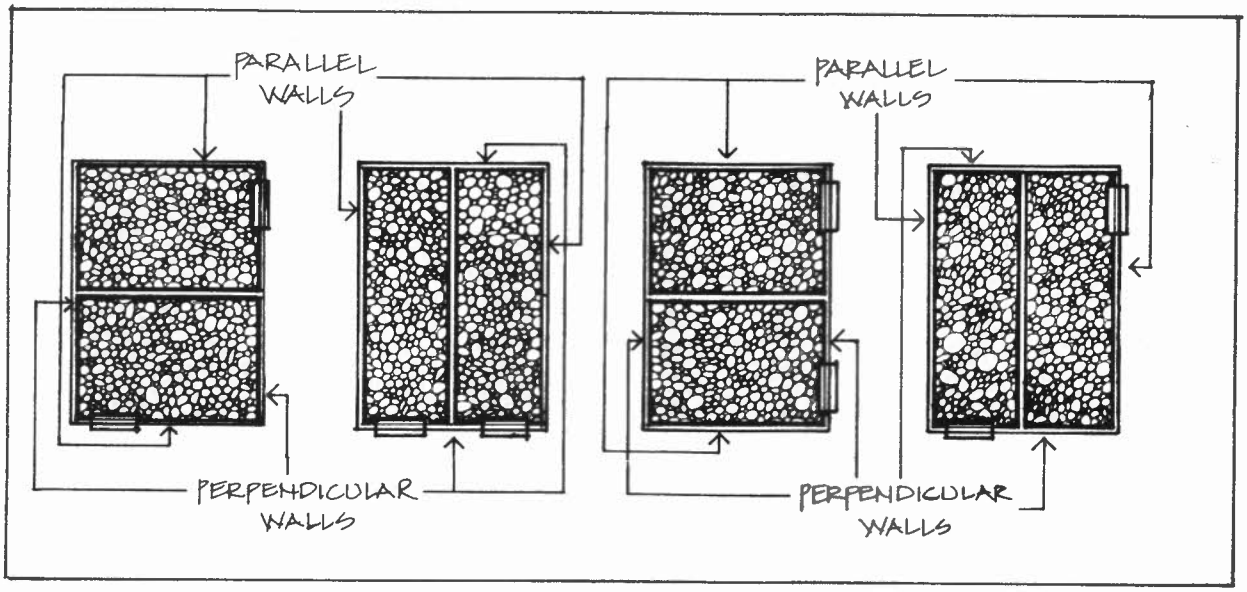


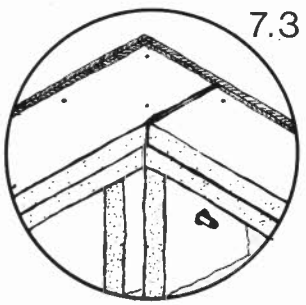
Figure 7.2 Relationship of Center Divider to Duct Openings

Frame the wall(s) where the duct openings will be located. If the opening is near a corner of the wall, frame the closest stud a minimum of 6 in. from the double corner stud, or 12 in. from the single corner stud(Panel C, 1-B2; 4-B2). This will allow space to predrill the corner studs for the corner bolt connections, once the panels are in place.

Frame the other stud for the opening at 24 in. on center to the first. Fasten a horizontal 2x6 (nominal) with its top edge 8 in. down from the bottom of the top plate, with two 16d common nails at each end.

SHEATHING: Sheathe the walls with 1/2 in. CDX plywood. Begin the sheathing flush with the outside edge of the double stud, and continue across to a point 6 in. beyond the single stud (1-B2). The plywood should be 6'-0" high, extending 1-1/2 in. above the top plate (3, 4-B2). Cut out the sheathing covering the duct openings. The four edges of the plywood should fall over a stud or plate. Fasten the plywood with 8d common nails at 6 in. on center around the sheet edges, and 12 in. on center at intermediate studs.

7.3 Bin Assembly



The four panels are tipped into place and bolted together. Each one is layed on a strip of sill insulation, which will help prevent heat loss through cracks between the bottom plate and the slab.

The panels are bolted together, and not just toe-nailed. This will keep the walls together during the loading process, and under the constant stress of the rocks weight for the life of the rock bin.

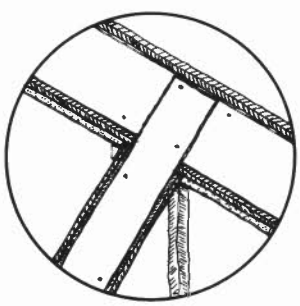
The R-19 fiberglass batt insulation between the studs will help keep the heat stored in the rocks within the perimeter of the rock bin.

Lay 6 in. wide asphalt impregnated "sill insulation" on the slab, around the perimeter of the rock bin. Force it down over the anchor bolts. Tip the first two walls into place over the sill insulation, matching a double-stud end with a single-stud end in the center. The 6 in. plywood extension on the outside of the single-stud end should cover the outer stud on the double-stud end (2-B3). If possible, depending on site conditions, nail the plywood to the outside double-stud. If one or both of the walls is a "bolt wall," fasten the nuts over the anchor bolts.

While bracing the two walls in place, drill 1/2 in. diameter holes from the single-stud side through the single-stud and the inner double-stud (2, 4-B3). The holes should be set back 3 in. from the inside face of the stud. The top and bottom holes should be 6 in. from the top and bottom of the panel, and then the rest should be spaced at 1'-8" on center (4-B3). Bolt the two panels together with 1/2 in. by 4-1/2 in. bolts with washers.

Fasten the next wall to one of those already standing, nailing the plywood extension, pre-drilling and bolting through the studs. Fasten the next one to it, and finally the last one to the first from the inside. Fasten the second top plate to the first with 16d common nails, staggered at 16 in. on center (1-B3). Overlap the plates at the corners for better strength (3-B3), and facenail with two 16d nails at each corner. Leave a 3-1/2 in. space in the two plates over the walls that will be perpendicular to the center partition (3-B3). Center the spaces over the center-lines of the walls, over the 2x6 (nominal) blocking flush with the interior of the panels.

Insulate the walls with R-19 fiberglass batt the full width of the studs. Staple the paper face to the inside face of the studs. Do not insulate the duct openings.



7.4 Interior Walls

The first step in this section is to assemble and add the center divider to the rock bin. The divider will keep the air from "short-circuiting" over the top of the rocks, making the air take the long route down through the rocks, under the divider, and up through the rocks on the other side.

The second step is to sheathe the inside of the rock bin. This will give the walls more structural integrity. The third step is to cover the sheathing with gypsum board. This not only protects the plywood from the heat, but it also provides a good air-tight seal with its tape and joint process. The gypsum is applied perpendicularly to the plywood

so that any air that does leak through a seam has a harder time reaching a seam in the plywood.

DIVIDER: The center partition or "divider" that separates the two sides of the rock bin should be built out of 2x4's (nominal) at 16 in. on center. The height of the 2x4 panel will be 5'-0½" (2-B4). The partition will be fastened to the two "perpendicular walls," with the bottom of its shoe plate 10 in. from the slab. This will allow space for the rigid insulation and concrete blocks in Section 7.5 to slide underneath it. The top plate of the divider will splice into the two spaces left in the perpendicular walls top plate (1, 6-B4).

Build the center partition, end-nailing the plates to the studs with two 16d common nails at each stud. Pre-drill 1/2 in. holes through the two end studs at 1'-0" on center, with the top and bottom holes no more than 4 in. from the top and bottom of the wall. Brace the divider in place inside the rock bin, matching up the bottom edge of its top plate with that of the panels' lower top plates. Center each end stud on the center-line of the 2x6 (nominal) blocking at the mid-points of the perpendicular walls. This will be under the spaces left in their top plates. Fasten the divider to the blocking, and into the 2x behind it, with 1/2 in. by 4 in. lag screws (3-B4).

Fasten the double top plate to the top plate of the center divider with 16d common nails staggered at 16 in. on center, splicing it into spaces left in the top plate of the perpendicular walls (6-B4). Fasten the ends to the perpendicular walls, face-nailing with two 16d common nails at each end (1-B4).

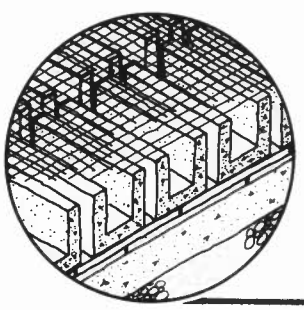
SHEATHING: Sheathe the inside of the rock bin with 1/2 in. CDX plywood (5-B4). Fasten with 8d common nails at 6 in. on center around the sheet edges, and 12 in. on center at the intermediate studs. Position the sheets of plywood with the long sides over the studs and the short sides over the plates. The vertical edges of the plywood must fall over a stud to help minimize air leakage and to support the plywood against the force of the rocks. Make sure the edges of the plywood butt hard against the floor, the corners, and against each other. Sheathe all the panels, as well as the center partition, from

the top to the bottom plate (4-B4). Don't forget to fasten the sheathing across the bottom of the "perpendicular walls," covering the 10 in. high gap between the center partition and the slab.

Run a 1/4 in. continuous bead of silicone caulk around the bottom edge of the plywood, where it butts against the slab (4-B4). (See Appendix A for caulk recommendations.)

GYPSUM BOARD: Fasten 1/2 in. gypsum board over the interior face of the plywood with its long sides perpendicular to the long sides of the sheathing. Fasten with 1 in. drywall screws at 8 in. on center around the edges, and 12 in. on center into every stud (where the nails are in the plywood). Stagger the gypsum board edges with the plywood edges at the interior corners (7-B4). If the plywood edge butts into another sheet of plywood, butt the gypsum into the plywood also, and then the perpendicular sheet of gypsum into the first piece of gypsum. Fasten the gypsum only to the sheathing on the panels, not to the sheathing on the center partition. Don't forget to fasten the gypsum board across the bottom of the "perpendicular" walls, covering the 10 in. gap between the center partition and the slab.

Apply the base coat of joint compound over the seams in the gypsum, and embed the reinforcing tape in it. Center the tape over all the seams and into all the corners. Apply two coats of compound over the tape, waiting for the first coat to dry before applying the next. While waiting for each coat to dry, apply a coat to the screw heads across the face of the gypsum. Repeat until tape and screws are covered with two coats of joint compound (7-B4). The joint compound will reduce air leakage from the bin.



7.5 Bond Block

This section deals with preparing the floor of the rock bin for the loading of the rocks. The insulation keeps the heat from flowing out through the floor slab. Since it is exposed to the air stream,

any insulation that burns, or is toxic when it does, cannot be used. The insulation must also be able to withstand 3 to 4 psi under the loading of the rocks.

The bond blocks, as described in the introduction, have a special core that directs the air flow towards and under the divider. Since the cores are open across the top of the blocks, and because there are spaces for air flow between the blocks themselves, all the blocks are covered with a layer of 3/4 in. self-furring metal lath. This must be the type of lath used. It is the only one structurally capable of keeping out the rocks and fines that could clog the lower air plenum.

INSULATION: Lay 2 ft. x 4 ft. x 1 in. sheets of rigid non-flammable, non-toxic insulation across the floor of the rock bin. Lay another 1 in. layer over the first, staggering all the edges. Do not lay one edge directly over any other (3, 4-B5). (See Appendix A for manufacturer's recommendations.)

BOND BLOCK: Center one row of concrete open-ended bond-beam blocks (8in. x 8in. x 16in.) under the center partition. The blocks should be placed with their open core (and 16 in. side) perpendicular to the center divider, to allow air to pass under the partition. Space the blocks from 2 in. to 4 in. apart, and 2 in. to 4 in. away from the "perpendicular walls." The actual distance will depend on the actual interior width of the box (1, 3-B5).

Using the centered row of blocks as a guide, place the blocks end to end across the whole floor of the rock bed, with their long sides parallel with the "perpendicular walls." Space the sides again at 2 in. to 4 in. apart, and away from the walls. Space them also 2 in. to 4 in. apart in the long direction, and away from the walls (4-B5). The actual spacing will depend on the actual interior dimension of the rock bin.

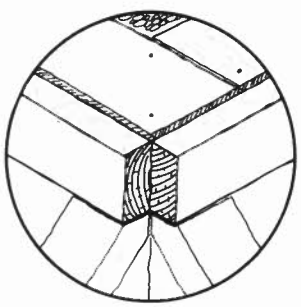
METAL LATH: Beginning at the end of the box, lay 3/4 in. self-furring metal lath across the block, with its long edge perpendicular to the block. (See Appendix A for lath manufacturer's recommendations.) Cut it 1'-0" longer than the interior width of the

box. Bend the three edges up the three walls. Overlap the next layer 6 in. over the first. Cut and bend the sheet up the two side walls. Continue until the last sheet bends a minimum of 6 in. up the divider (1,3,4-B5).

Repeat for the other side of the rock bin, overlapping all the layers 6 inches, and bending a minimum of 6 in. up the walls (1-B5).

DUCT COLLARS: Have two duct collars fabricated out of 30 gauge sheet metal. The collars will have 1-1/2 in. nailing flanges around one end of them. The collars will be 8 in. high, 22-1/2 in. wide and 9 in. from back to front (2-B5).

Caulk around the perimeter of the duct collar openings on the gypsum board (inside the bin) with a 1/4 in. continuous bead of silicone caulk. Insert the duct collars from the inside of the bin, pushing the nailing flanges into the caulk. Fasten around the nailing flanges with 1-1/2 in. drywall screws at 4 in. on center (2-B5).



7.6 Bracing and Loading

The rock bin must be prepared for the loading of the rocks by bracing the walls. The braces must remain in place until the cover of the rock bin is completely fastened in place. The cover will then take over the job of keeping the tops of the walls from spreading apart.

The rocks must be tested and cleaned before they are loaded into the bin. Both these steps are important to the performance of the bin. The correct amount of void between the rocks, determined in the test is essential for proper air flow. And if the rocks go into the bin covered with dirt, the dirt could fall down between the rocks and plug the holes in the metal lath. This could cut off the air flow from one side of the bin to the other.

BRACING: All of the "bolt walls" must be braced against the impact and sustained load of the

rock, until the lid is securely bolted in place. The braces are 2x4 (nominal) lengths, which run at a 45° angle from a 2x4 (nominal) "ledger" nailed to the top of the bin walls, to a 2x4 (nominal) "shear plate" shot into the slab.

Nail continuous 2x4 ledgers to the sides of the "bolt walls," with their top 1-1/2 in. faces flush with the top of the walls. Fasten temporarily with double headed 16d nails staggered at 16 in. on center. Stay within 1 in. of the center-line of the 3-1/2 in. face when nailing, or the nails may miss the top plates (1, 2-B6).

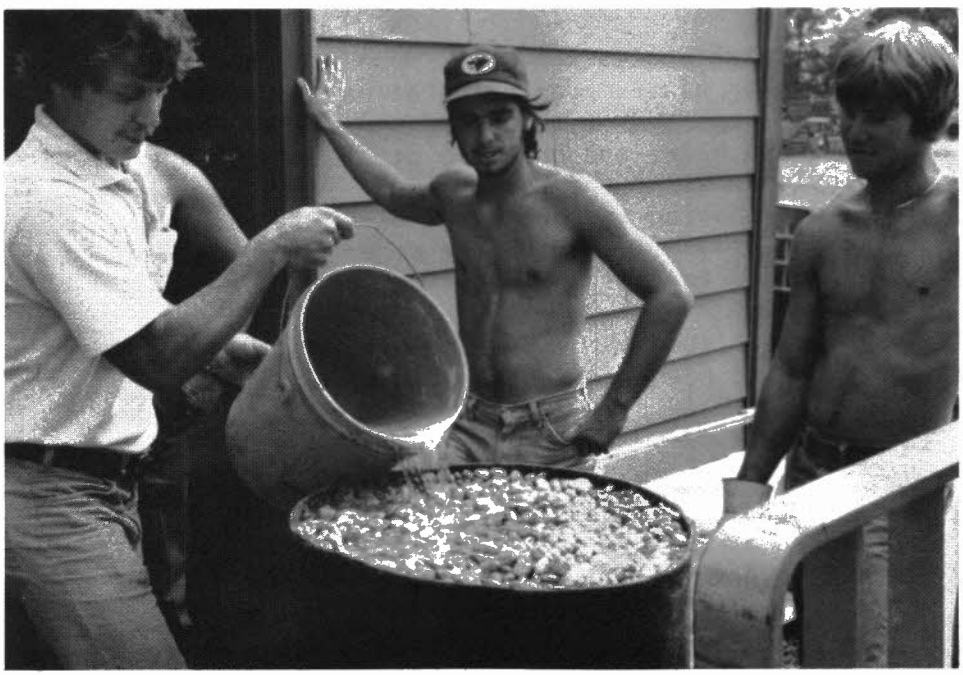
Lay the 2x4 shear plates on the slab, with the outside 1-1/2 in. side 6'-0" away from the side of the bin. Shoot into the concrete with 1/4 in. x 3-7/16 in. pins at 24 in. on center (1, 2-B6).

Cut 2x4 braces that will span from the ledger to the shear plate. Beginning at one corner of the bin; wedge one end of the brace under the ledger, bow the 2x4 down, and butt the other end against the inside edge of the shear plate. Work across the side, spacing the braces at 2'-0" on center. Place one brace flush with the other corner. Repeat this process for all the "bolt walls" (1, 2-B6).

Do not remove the braces until the cover to the rock bin has been fastened in place.

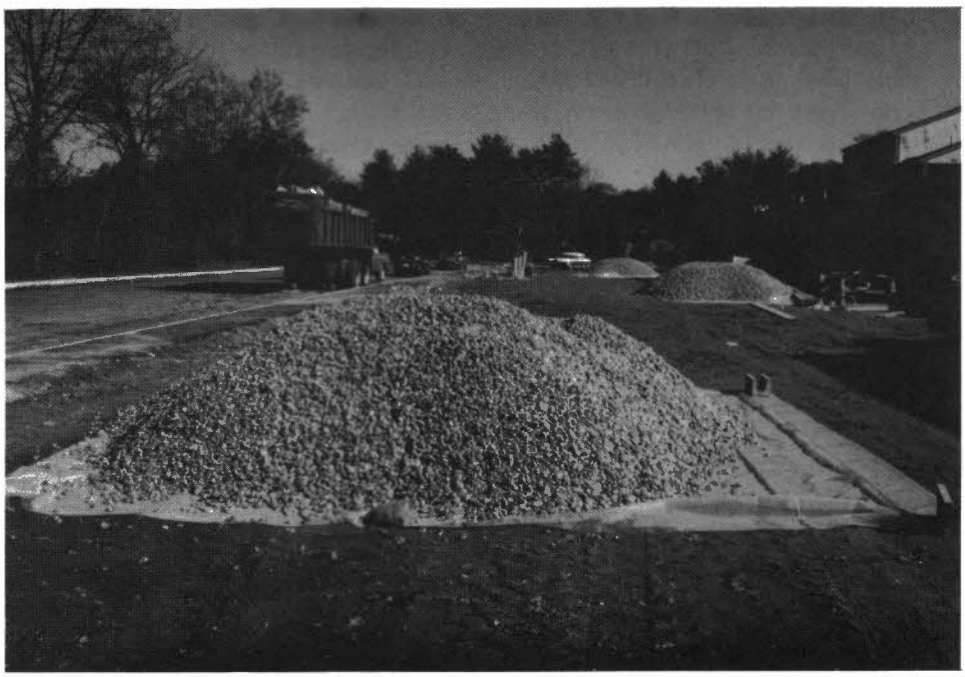
ROCKS: The rock that will be used in the bin should be a mixture of 3/4 in. to 1-1/2 in. crushed rock. To get this mixture, have the plant screen the rock twice; once through a 1-1/2 in. screen to filter out any rocks bigger than 1-1/2 in. in diameter, and once through a 3/4 in. screen to filter out any rocks smaller than 3/4 inch. This mixture of rock should give the correct ratio of solids to voids, and the correct amount of surface area. Both are needed for good heat transfer, from the air to the rocks (storage), or the rocks to the air (delivery). The mixture should be washed at least once, and preferably twice, before leaving the plant.

VOID TEST: Before purchasing the rock, a void test of the mixture should be run. The mixture must be graded to contain no less than 40% voids around the rocks, or the air will not be able to pass by the rocks at the proper rate. If the air goes by the rocks too slowly or too quickly, the heat transfer in the storage or the delivery modes is not the rate upon which the size of the rock bin was based.



Void Test

Fill a 55 gallon drum with the rock sample. Pour measured quantities of water into the drum, one gallon at a time. Keep track of the number of gallons the drum receives, until it overflows. If the drum receives at least 22 gallons of water, the sample passes the test.



Unloading the Rocks Next to the Building

Have the rock delivered to the site and dumped near the building onto a sheet of 6 mil polyethylene. The plastic will help keep the rocks clean. Do not have the truck dump the rocks into the box.

Hose down the rocks, forcing the fines and small pieces of debris to the bottom of the pile. Let the rocks dry before loading them into the bin.

NOTE: It is easier to load the rock and fasten the lid, if the first floor framing is not in place yet.

Load the rocks into the bin, filling each side equally during the loading to minimize the strain on the divider. Place the rock slowly, in small loads, to minimize the impact on the metal lath, blocks, and bin interior. Fill the bin to a point 4'-0" from the floor slab. Place the temperature sensor piping in the bin (see TEMPERATURE SENSORS below) and then fill the rest of the bin to a point 12 in. from the top of the walls (1-B6). Do not take the rocks (with the debris) from the bottom of the pile. Any fines or debris could work its way down through the rocks and could plug the holes in the metal lath.

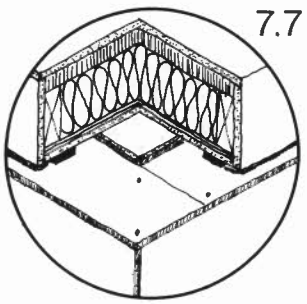
TEMPERATURE SENSORS: Two temperature sensors should be placed in the rock bin, one on each side of the divider. (See Appendix A for sensor manufacturer recommendations.) The sensor that came with the differential controller will be placed in the cold side of storage, and the sensor attached to the remote bulb thermostat will be placed in the hot side. Remember, the hot side of storage is the side connected to the return duct of the collector, and the cold side is the side connected to the supply duct.

Drill two 1/2 in. diameter holes 1'-0" away from the duct collars (5-B6), and 4'-0" from the floor slab (6-B6). Cut two 3 ft. long sections of 1/2 in. outside diameter iron pipe and thread one end of each. Feed the pipes through the holes until 2 in. are left extending on the outside of the bin. Caulk continuously with silicone around each pipe where they intersect the gypsum board (3-B6).

Apply silicone caulk around the pipes where they intersect the exterior plywood. Place pipe collars over the pipes, caulk around their edges, and fasten them to the rock bin (3-B6). Load the rocks gently over the pipes.

Feed the sensors, with the wires connected, into the pipes, until they meet resistance at the end of the pipe. Feed the wires through holes in the end of 1/2 in. diameter pipe caps, and fasten the caps to the pipes. Caulk the holes in the caps (3-B6).

7.7 Cover Assembly


7.7

The cover serves two functions. One is to keep the heat from flowing out the top of the rock bin, so it is insulated with both fiberglass batt and extruded polystyrene. The cover also has to keep the tops of the bin walls from spreading under the load of the rocks within. Therefore, the number of bolts is very important.

The seam between the cover and the top of the walls is an important seam to make air-tight. That is why the process includes a neoprene gasket plus a seal of silicone caulk <u>all the way</u> around the perimeter.

The seal across the top of the center divider is also important. It must be air-tight, to keep air from "short-circuiting" from one side to the other. This is why two gaskets instead of one are used, with a space left between them where the lag screws can pass by without disturbing them.

<u>FRAMING</u>: The frame for the cover will be 4 in. smaller in width and length than the width and length of the rock bin walls. Frame the cover with 2x4's (nominal) at 24 in. on center, as if it were a wall being framed, with its 2x4's parallel with the divider wall. Frame one 2x4 with its center-line along the center-line of the cover. End-nail each "plate" into the studs with two 16d common nails at each end of the studs (3-B7).

INTERIOR FINISH: Sheathe the inside of the cover with 1/2 in. CDX plywood (2-B7). Fasten with 8d common nails at 6 in. on center around the sheet edges, and 12 in. on center at the intermediate 2x4's. Position the sheets of plywood with their long sides over the 2x4's, and the short sides over the perimeter frame. The edges of the plywood must fall over the framing to help minimize air leakage and to support the plywood. Carry the sheathing to the outer edges of the perimeter framing members (2-B7).

Fasten 1/2 in. gypsum board over the interior face of the plywood with its long sides perpendicular to the long sides of the sheathing. Fasten with 1 in. drywall screws at 8 in. on center around the edges, and 12 in. on center into every stud (where the nails are in the plywood). Sink each screw just below the surface, to be covered with joint compound later (2-B7). Carry the gypsum to the outer edges of the perimeter framing members (2-B7).

Apply the base coat of joint compound over the seams in the gypsum, and embed the reinforcing tape in it. Center the tape over all the seams. Apply two coats of compound over the tape, waiting for the first coat to dry before applying the next. While waiting for each coat to dry, apply a coat to the screw heads across the face of the gypsum. Repeat until tape and screws are covered with two coats of joint compound (2-B7). The joint compound will reduce air leakage from the bin.

INSULATION: Insulate between the framing members with 3-1/2 in. of fiberglass batt. Sheathe over the top of the members with 4x8 sheets of tongue and groove rigid extruded polystyrene insulation. (See Appendix A for extruded polystyrene manufacturer recommendations.) The edges of the sheets should all be supported by the framing members. Fasten the styrofoam with 1-1/2 in. nails with 7/16 in. heads, at 12 in. on center around the edges and over the framing members. Carry the sheathing to the outer edges of the perimeter framing members (2-B7).

EXTERIOR FINISH: Cover the top and side faces of the rock bin cover with 1/2 in. gypsum board, with its long sides perpendicular to the long sides

of the plywood (2-B7). Fasten with 2 in. drywall screws at 8 in. on center, and 12 in. on center into every framing member (note the nails in the plywood).

Cover the four sides of the cover first, from the bottom edge of the gypsum on the bottom (interior) face of the cover, to the top of the styrofoam insulation. Then cover the top of the cover, lapping the perimeter edges over the top of the side gypsum (2-B7).

Apply the base coat of joint compound over the seams in the gypsum, and over the edges of the cover (start with the top corners). Center the tape over all the seams and over the top four corners/edges of the cover. Apply two coats of compound over the tape, waiting for the first coat to dry before applying the next. While waiting for each coat to dry, apply a coat to the screw heads across the faces of the gypsum. Repeat until the tape and screws are covered with two coats of joint compound (2-B7).

Turn the cover over, and repeat the process for the bottom four corners/edges of the cover (2-B7).

Pre-drill holes for the 1/2 in. x 8 in. lag screws. The 3/8 in. diameter holes should be drilled around the perimeter of the cover, at 2'-0" on center. The center-line of the holes should be set 1-1/4 in. back from the side edges of the cover. Also pre-drill the holes at 2'-0" along the center-line of the cover, that will be over the divider of the rock bin. These screws will run down through the 2x4 at the center-line of the cover, and into the top plate of the divider.

NEOPRENE GASKETS: Run a 1/4 in. continuous bead of silicone caulk around the top of the perimeter walls, 4 in. back from the exterior face of the rock bin exterior sheathing. Lay a continuous line of 1/2 in. by 2 in. closed cell neoprene gasket over the caulk, with its interior 1/2 in. face set 5 in. back from the exterior face of the rock bin exterior sheathing (2-B7). (See Appendix A for silicone caulk and neoprene gasket manufacturer recommendations. Do not use polyvinylchloride foam tape, but closed-cell neoprene. Check with the manufacturer to be sure

their neoprene can be used with silicone caulk, because some kinds cannot.)

Run two continuous 1/4 in. beads of caulk across the top plate of the divider wall, each set 1 in. inside the exterior edge of the plywood. Lay one continuous gasket over each line of caulk, with its exterior edge lined up with the exterior face of the plywood (2-B7). Let the caulk set before laying the rock bin cover over the gaskets.

COVER FASTENING: Lay the cover in place on top of the gaskets, with its side edges 1-1/2 in. inside the exterior face of the sheathing on the walls (2-B7). Do not slide the cover across the gasket, but set in place. Fasten the cover in place with 1/2 in. by 8 in. lag screws, through the predrilled holes around the perimeter and across the center-line. Fill the gap left around the bin perimeter, between the gypsum gasket and top plate with caulk. (See Appendix A for urethane caulk recommendations.)

RETROFIT: It may be awkward, but it is necessary that someone crawl over the top of the cover and caulk any seams that can't be reached directly.

Remove the temporary bracing, shear plate, and ledger after all the lag screws have been fastened. The ducts may now be attached to the duct collars and the rock bin connected with the rest of the system. The rock bin is now ready to be hooked up to the air handling system and the collector.