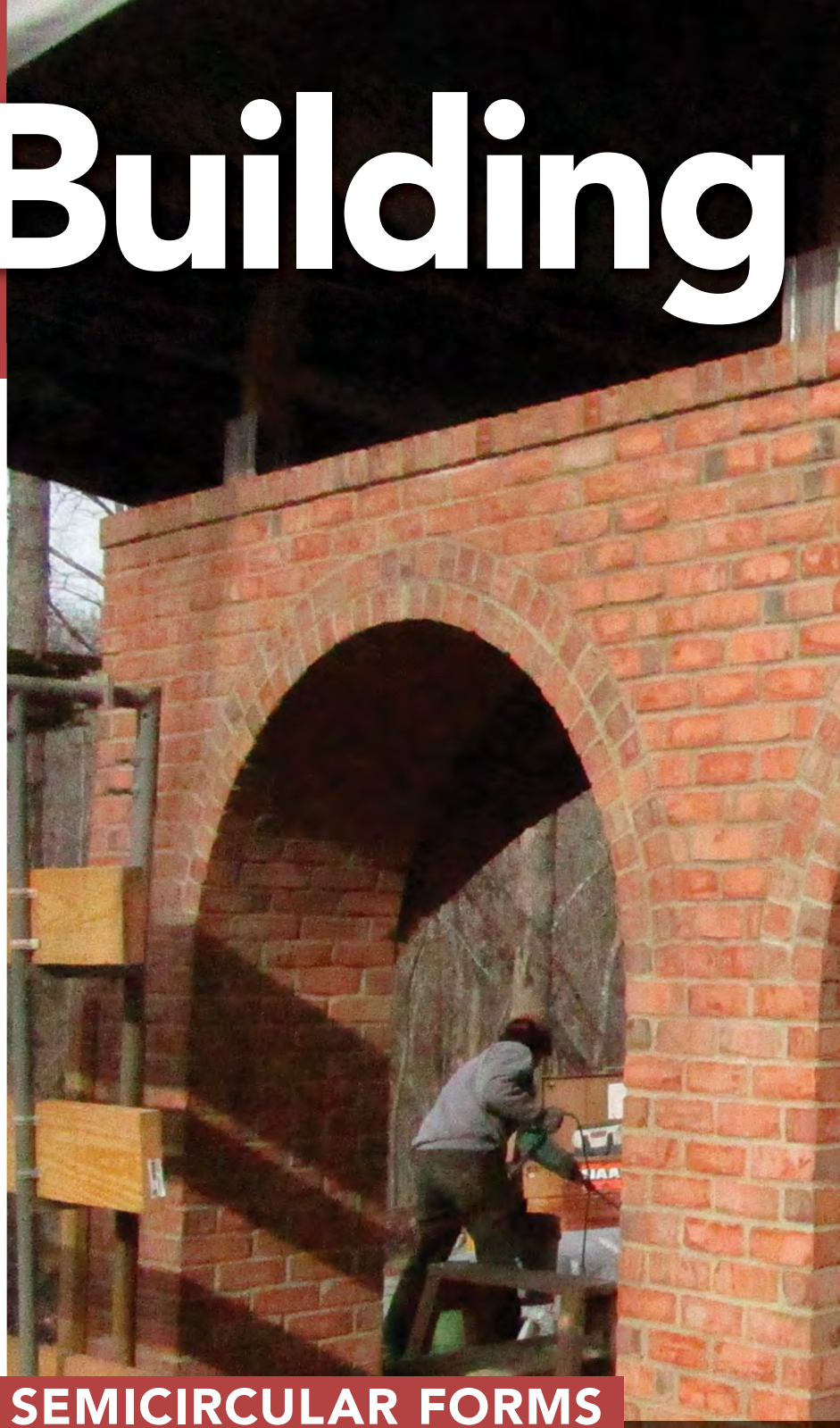
Building

A seasoned mason's guide to laying out and laying up a classic feature of Roman architecture

BY JOHN CARROLL



I've been doing masonry work for decades, and the vast majority of that work involves setting rectangular shapes down in straight lines. But once in a while, I get to work outside the straight lines and build brick arches, which demand a higher level of planning and layout. I recently built a series of brick arches for the support structure under an addition.

Although the arch is a very strong and time-tested architectural element, the arches for this project were mainly aesthetic. The actual support for the addition came from six cast concrete pillars that were placed before I arrived. My job was to add brick veneer around the columns and then to connect the columns with arches: four semicircular arches (what I call Roman arches) on the sides and a segmental arch at one end. This article will cover my approach to the general process of laying out and building the Roman arches.

The grade under this addition sloped down, and on the higher side, the contractor had joined the columns with poured-concrete sections at bench height, while on the lower side he left those spaces empty to provide walkout access. The first task was laying the brick veneer around the concrete columns up to where the arches would begin. I went 18 courses high, and with some careful planning, the top courses all ended up three bricks wide, which gave me an all-important consistent starting point for building the arches. □

John Carroll is the author of *The Complete Visual Guide to Building a House* (The Taunton Press, 2014). Photos by Matthew Carroll Navey.

BUILD AND SET THE SEMICIRCULAR FORMS

I typically make my own forms (called "centerings") when building arches, but this time the general contractor, Kevin Davidsaver, took care of fabricating them. These Roman arches all have a 73¼-in. span. To ensure that the forms fit between the columns, he built them with ⅛ in. of play on each side.

The forms for these arches consist of half-circle faces cut out of ¾-in. plywood using a router and a circle jig 1. When setting the pivot point and the radius of the jig, be sure to deduct for the skin that covers the arch form—which in this case is ¼-in. hardboard 2. Davidsaver made the forms 1½ in. narrower than the 24-in. thickness of the walls to keep them from interfering with the stringlines we use to keep the walls straight.

I laid these arches with two rowlock courses—"rowlock"

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Brick Arches

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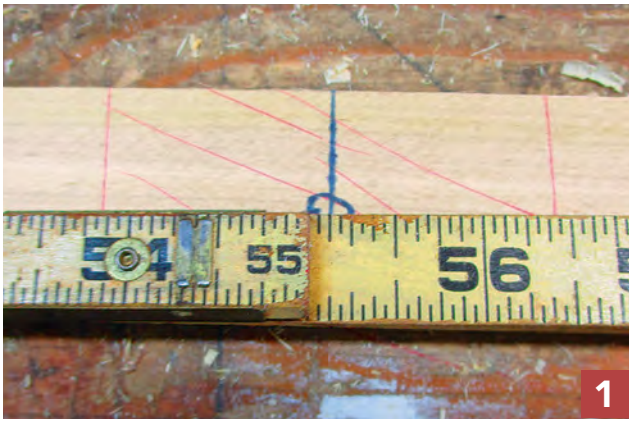
means the bricks are laid on their long, narrow edge rather than flat on their widest surface (in this case, relative to the arch). To make the tops of the arches work out even with the brick courses on the columns, I use my story pole to set an elevation string for the brick course near to the top of the arch. The total height of the arch face is 7⅜ in. (two rowlock courses plus a ⅜-in. mortar joint), so we set the forms so their tops are exactly 7⅜ in. below the string 3, and then secure the forms in place with screws.



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SPACE THE BRICKS

I planned to lay the bricks for the arch in an offset (staggered) "running bond" pattern. To have the same pattern where the arch meets the columns on both sides, you need an odd number of courses. To lay out an odd number of courses on an arch, masons start with a "keystone" brick that straddles the exact center of the arch. I begin by marking the form's center (its apex), then I measure and mark half the thickness of a brick in both directions.

To get the spacing for the courses on the first layer, I first rip a 1/8-in.-thick strip of wood from clear 2x material for a story pole. I hold one end of the strip at the bottom of the form, tight to the course on the column where the arch starts, bend the strip around the form, and transfer the location of the center brick onto the strip.

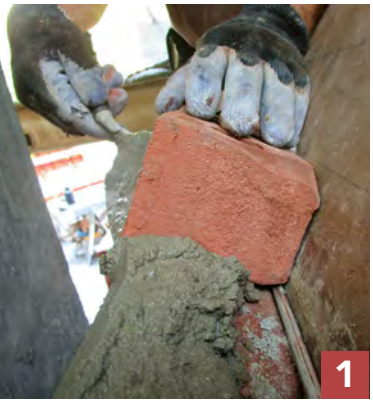
After laying the strip flat on top of the workbench, I measure the distance from the end that touched the column to the far side of the center brick **1**. In a typical mason's layout, each "space" represents the size of one brick plus one mortar joint. By measuring to the far side of the center keystone brick, the number of spaces (bricks plus mortar joints) in the layout will be consistent for both sides of the arch. For these arches, the distance from the column to the far side of the center brick was 56 7/16 in., which I divided by 3 1/8 in.—the course spacing I'd used on the columns below the arches. I convert those measurements to decimal equivalents before doing the division to get the number of spaces; the result of this particular math problem is just over 18.

Because the tapered mortar joints on the arch are wider at the top, this spacing tends to look too big in the finished arch. I add a space, making it 19, and re-divide the overall distance by this figure. For this arch, that results in a spacing of 2.9703947 in., or about 1/32 in. shy of 3 in. This spacing yields a fairly narrow 1/4-in. mortar joint where the rowlock courses rest on the form, but the tapered mortar joints make that spacing look acceptable.

In most construction—especially in masonry work—1/32 in. is usually negligible, so rounding up the spacing to an even 3 in. would seem to make sense. But when 1/32 in. is added 19 times, the cumulative gain of 9/16 in. in 18 courses becomes significant; the last course would not fit in the remaining space. To solve the cumulative error problem, use a regular old calculator and convert to metric measurements, which eliminates the process of changing inches to decimals and back again for the layout.

Here's how it works. The metric distance on the story-pole strip is 143.4 cm, which I divide by 19 to get 7.5473684 cm for each space. I enter that into my calculator. Then I use the add-on feature to add that number to itself, rounding the total either up or down to the nearest millimeter. For example, I round the initial number down and record it as 7.5 cm. Adding the full measurement to itself gives me 15.094736, which I round up to 15.1 cm. I continue the add-on process through the entire 143.4 cm and record the results.

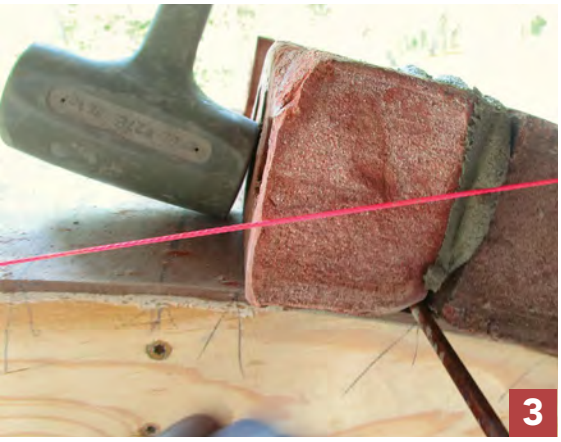
I then carefully transfer those measurements to the story-pole strip **2**. The rounding represents less than 1 mm between spaces, or less than 1/25 in. With the spaces laid out on the strip, I transfer the layout to the form **3**. I mark the entire form on both sides and connect the layout marks with lines across the form to guide the actual course placement **4**.



LAY THE FIRST COURSE

To create the rowlock courses around the arch, the edge of the bricks have to lay flat against the curved form. To continue the running-bond pattern from the columns, I start every other course with a half brick. To keep the outside faces of the bricks in plane with the wall, I set them just inside guide strings I stretched between my corner poles.

For structural purposes I want to fully pack the joints with mortar. But I also want to end up with neat, clean, and properly finished mortar joints on the inside face of the arch, which is hidden until the form is removed. To satisfy both of these goals, I pack the top edge of each brick about three-quarters full as I lay the bricks, leaving the bottom quarter clear of mortar 1. That bit I fill and tool after removing the form.



The orientation of the bricks changes as you work up and around the arch, starting nearly level but becoming increasingly vertical as you go up. The "keystone" brick in the center of the arch is completely vertical. On the bottom courses, I lay down a bed of mortar on the preceding course, but as the courses tilt up, it's easier to butter each brick with mortar as I set it in place 2. With both methods, I always leave the inner edge of the joint clear of mortar. After placing each brick, I tap it to the layout lines marked on the form 3.

To keep the concealed joints free of mortar in situations such as this, masons typically insert removable spacers. For the horizontal joints, I set ¼-in. metal rod on the form against each course as I go to help keep that part of the joint clear of mortar until later 4. To keep the vertical head joints between the ends of the bricks clear, I push a piece of foam backer rod into each joint against the form 5. After filling the joint with mortar, I cut the rod even with the top of the bricks 6. After I finish laying each course, I fill and tool the joints between the rowlock courses on both faces of the arch 7.

LAY THE SECOND COURSE

The only visible part of the second rowlock layer is the exposed ends of the bricks, so this layer goes more quickly and easily. But the layout and the installation of the bricks on this layer have to be just as precise as the first. To offset the courses at the apex of the arch, I have to center a mortar joint directly over the keystone brick on the first rowlock course. So I measure and mark that joint 1.

Because the circumference of the arch above the first rowlock course is larger, I need a separate story-pole strip for the second course. As before, I use the add-on calculator feature and my metric tape to measure and mark the spaces on the strip for the second layer. This layer has 20 courses on each side of the arch. I transfer the spacing layout from the strip onto the bricks of the first layer 2. Again, I lay out all the courses on both sides of the arch and connect the marks with guide lines on top of the first layer 3. With no concerns about keeping the inner part of the joints clear on this course, I pack all the joints completely as I lay the bricks 4. And because only the ends of the bricks will be visible, I lay the second rowlock course in a stacked bond instead of a running bond, which takes less time and uses materials more efficiently.

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REVEAL THE INNER ARCH

After both brick courses for the arches are laid, the contractor and owner have us form and pour steel-reinforced concrete above each arch, which is probably overkill from a structural standpoint. After giving the brick arches several days to cure, we remove the centering forms to expose the inside surfaces of the arches.

Before the joints can be filled and finished, they have to be thoroughly clean and clear of debris. For these joints, we first remove the foam backer rod that we used to keep the vertical joints open 1. Using a hammer and chisel, I remove stray crumbs of mortar from the faces of the bricks 2. Then I run a grinder equipped with a ¼-in.-thick masonry blade along the horizontal bed joints to remove any mortar that got past the steel rods we used to protect them 3. The joints here are in good shape—all of our careful and methodical work while laying the bricks pays dividends. The final step before filling the joints is spraying them with water so that the brick and hardened mortar don't suck moisture out of the new mortar as we fill the joints 4.

FINISH THE JOINTS

For filling the joints, or "tuck-pointing," we use mortar that is slightly thicker than what is typically used for laying the brick. After mixing this stiffer mortar, we let it slake (sit) for about 20 minutes, which is a bit longer than the usual slaking time. The stiffer mortar sticks more readily to the bucket trowels that we use as hawks for dispensing the mortar.

Tuck-pointing trowels are very thin and come in a variety of widths. Because of the irregular bricks, these joints vary in width slightly. With all of our tuck-pointing trowels kept close at hand, we choose the widest one that will fit into each joint to maximize the amount of mortar we can push in 1. It usually takes three or four passes to fill the joints up to the face of the bricks. To dispense the mortar for the vertical head joints, we switch to a narrower bucket trowel 2.

After letting the mortar in the joints set up slightly, we run a barbell jointer over the joints to give them a concave profile, pressing hard as we go 3. This applied pressure further packs the mortar into the joint, pressing it tight against the edges of the bricks. We finish off the joints by brushing them lightly with an old bristle paintbrush 4.


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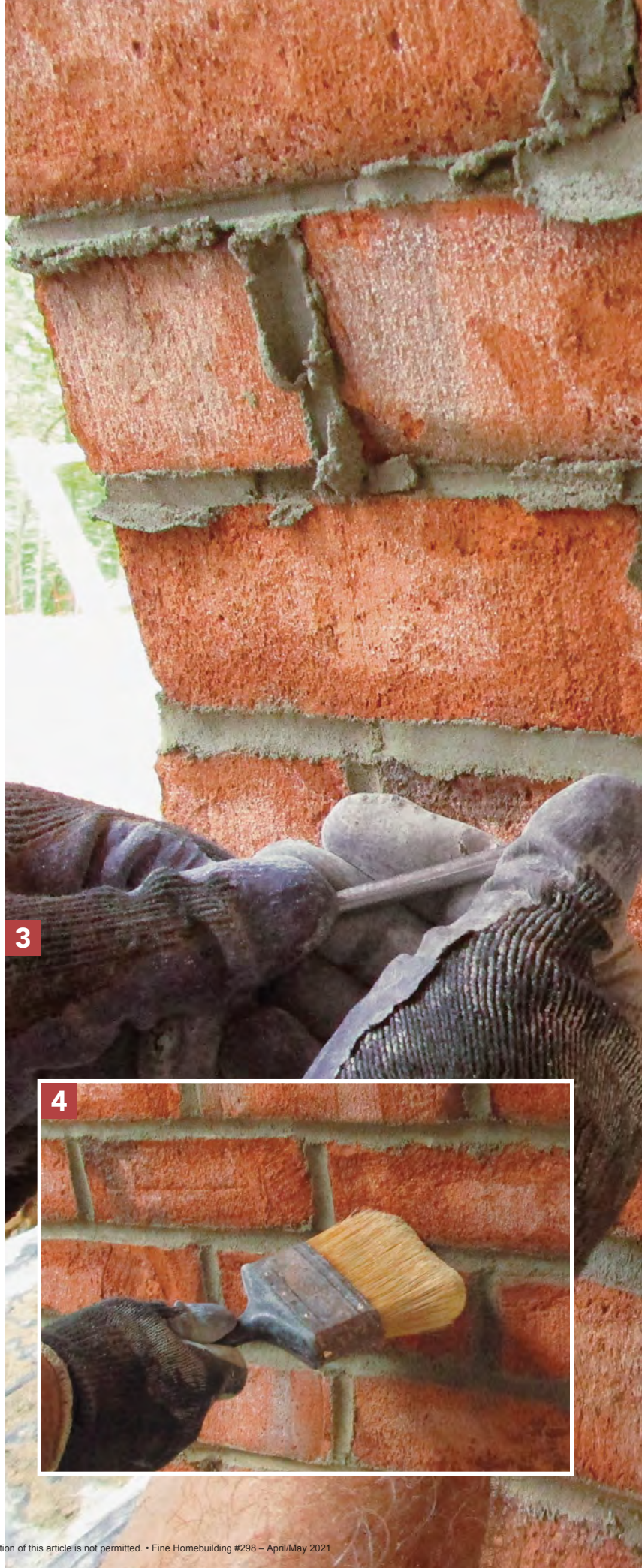
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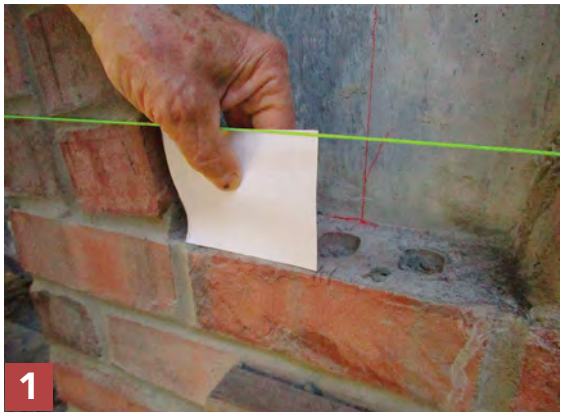
FILL IN THE FIELD

Filling in the brick veneer between the arches requires cutting bricks to fit against the curved rowlock courses. The easiest and most accurate way to template the shapes is with cards cut to the width of a brick plus one mortar joint. I cut the angle on the card and test-fit it in place 1. When I'm happy with the fit, I transfer the shape to a brick 2, and then used a grinder equipped with a diamond blade to cut the angle. The cut brick then fits perfectly 3.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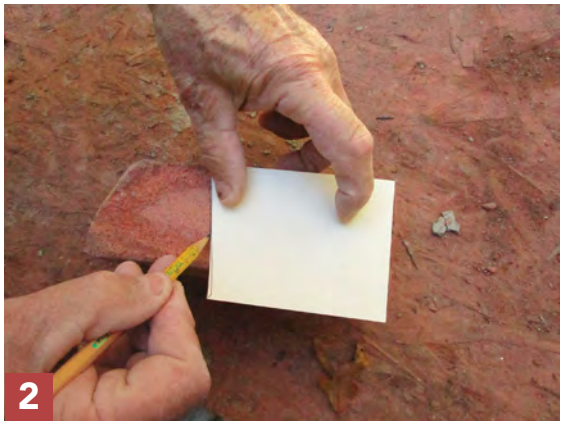
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