Leonard Studio Photos

Erection of two main spans by two derricks operating in opposite directions from mid-river pier.

Spanning the Mississippi at Chester, Ill.

The highway bridge now under construction over the Mississippi River at Chester, Ill., to connect Illinois Route 3 and Missouri Highway 51, will be completed by spring. A 22-ft. wide roadway and two sidewalks will be provided.

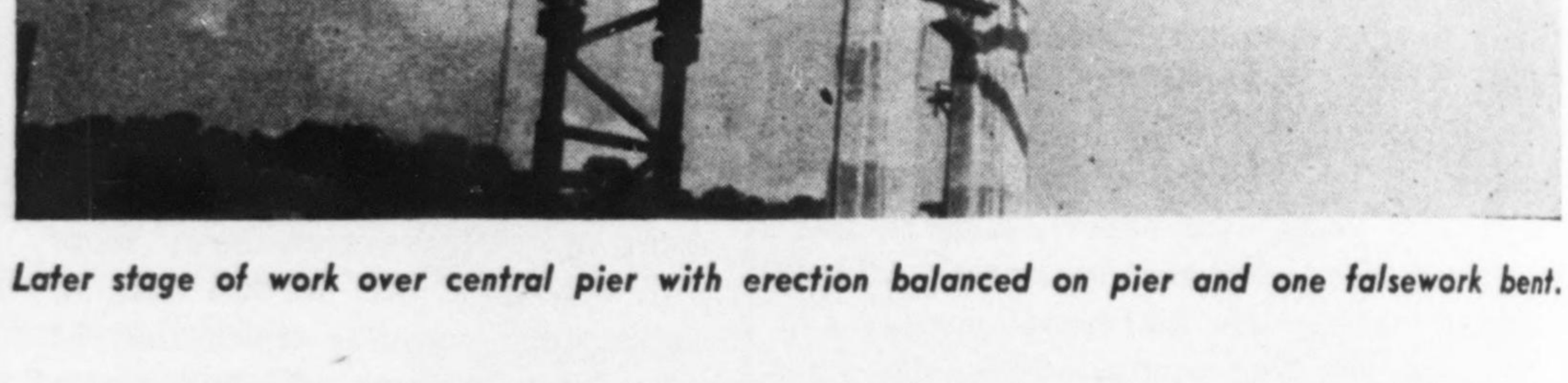
Over the main channel a 1,340-ft. long continuous through truss unit of two equal spans is used. The trusses are 28½ ft. center to center and they are 100-ft. deep over the mid-river pier. This central unit is flanked at each end by a 500-ft. long continuous deck truss, while the Illinois approach is one 60-ft. I-beam span and the Missouri approach seven 60-ft. similar spans. Overall length is 2,826 ft. A clearance of 107 ft. is provided at extreme low water.

The mid-river pier and the Missouri pier supporting the main trusses were sunk with pneumatic caissons and built on rock 100 and 110 ft., respectively, below low water. The main pier on the Illinois side was constructed by means of an open cofferdam and rests on rock about 30 ft. below the surface. All piers for the Illinois approach are also carried to rock, but those for the Missouri approach rest on timber piling.

Superstructure erection

Main-span erection began at the mid-river pier and was carried out with a derrick barge and two derricks mounted on the bridge's floor system and proceeding in opposite directions. The first temporary falsework bent was located on the Illinois side at a panel length from the mid-river pier. The derrick barge then erected the two lower chords, the floor system and a portion of the trusses for the first Illinois panel. Next the two derricks, facing in opposite directions, were placed on top of the pier. After they had erected together the top chord sections over the central pier, erection was cantilevered in both directions with a balance maintained on the pier and the falsework bent. In all, three bents were required for the Illinois span, while one bent requiring a cantilever of 402 ft.—the longest on the job—was used for the Missouri side.

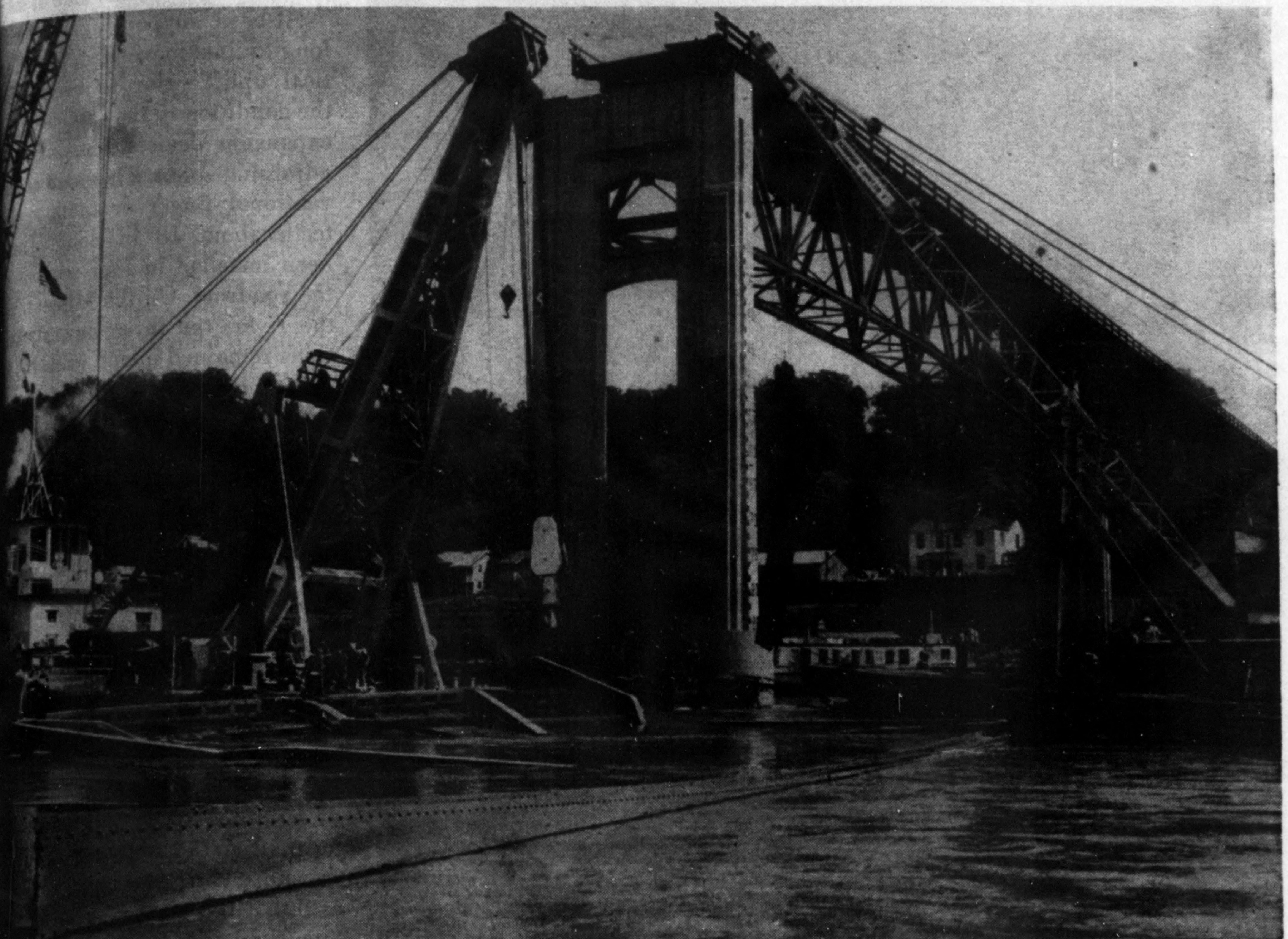
Later stage of work over central pier with erection balanced on pier and one falsework bent.



Two 670-ft. main spans fully erected. One falsework bent in each span is holding camber until riveting can be completed.

Each steel falsework bent rested on 40 timber piles 80-ft. long and of 40-ft. penetration. The piles were braced above water by bolted timbers and below with ¾-in. dia. steel cable. High water and swift currents occurred during the 3-month period while the bents were in place. A moderately severe 10-day flow of ice constituted a serious hazard to the falsework during this phase of the construction work.

Construction, which started October, 1940, is financed by the city of Chester. Massman Construction Co., Kansas City, with a $1,090,000 contract, is doing the foundation and superstructure work. Sverdrup & Parcel, St. Louis, are designing and consulting engineers.



Heavy hoisting equipment removes torn and twisted bridge trusses from the muddy Mississippi at Chester, Ill.

Removing a Bridge From the Mississippi

tents in Brief—Heavy marine blasting removes 500 tons of the wreck- of the Mississippi River bridge at Chester, Ill., to provide a 300-ft. navigation channel. Salvage operations completed in 15 days and out mishap, despite unusual hazards. Reason for failure of bridge in wind still unexplained.

OM does a bridge constructor a large river bridge, then turn nd and remove part of it from the bed within a period of two years. This is what happened at Chester, when the same contractor who a bridge over the Mississippi there in 1942 recently removed t. of the two 670-ft. continuous spans which toppled into the during a windstorm of tornadic sity on July 29.

owners of the bridge, the Chester Bridge Commission had the first nsibility for removing the col- truss spans. But as guardians of continuous and uninterrupted flow of river traffic the Corps of Engineers, U. S. Army, had the task of expediting the removal of a sufficient length of bridge to restore full use of the navigation channel. Accordingly these two agencies met and agreed that the Army Engineers would remove 300 ft. of bridge on the Illinois side of the river. Despite the fact that the job promised to be dangerous, difficult and expensive (steel that cost $9\frac{1}{2}$ cents per lb. erected cost 5 cents per lb. to remove), speed was imperative.

Barge tows could use a channel 150 ft. wide and 9 ft. or more in depth between the Illinois bank of the river and the pier which had supported the east end of the continuous trusses, but there was always the danger that it might be blocked. A salvaging contract, therefore, was negotiated, equipment was mobilized and removal operations of the part of the steel in the main channel were started Aug. 13. Work continued 12 hours a day (night operations being considered too hazardous), and fifteen days later the 300 ft. of bridge, containing some 500 tons of steel, was completely removed and piled on the Illinois shore a short distance below the site.

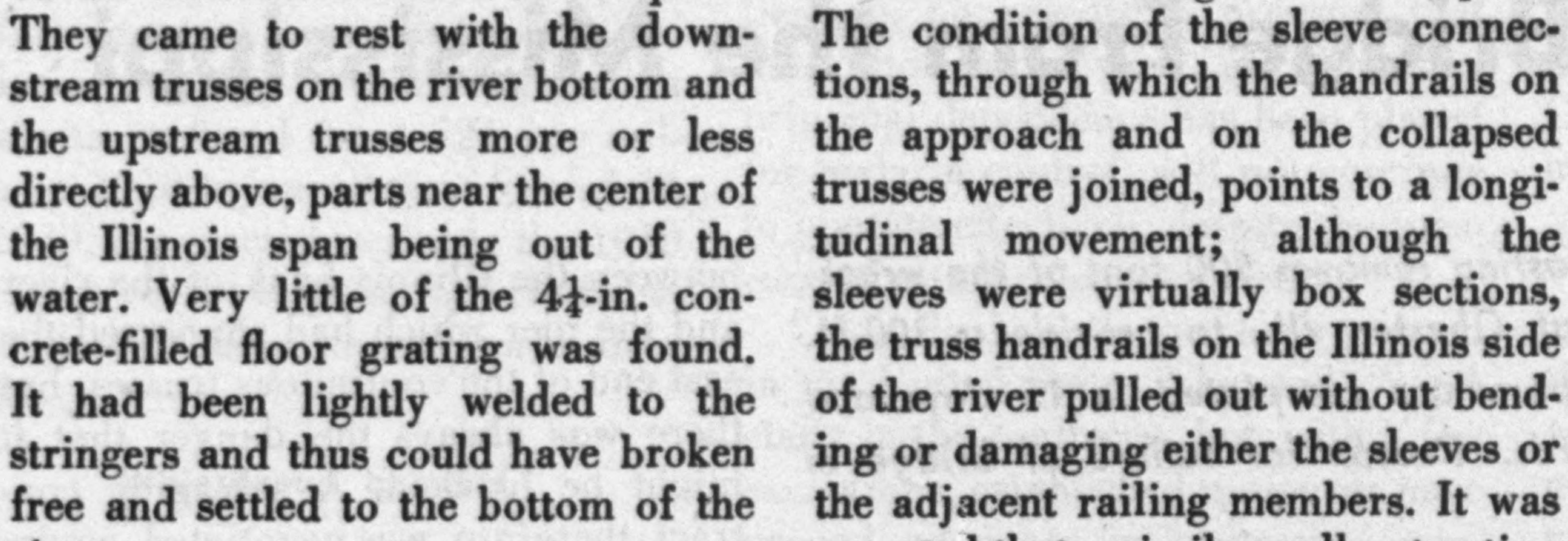
Manner of failure still obscure

It had been hoped that closer examination of the wreckage, which salvaging afforded, might throw new light on the manner of the failure (*ENR*, Aug. 10, 1944, p. 138), but

After a twisted mass of dynamited steel was raised above the river, members were burned into convenient lengths for loading onto barges.

only a few new facts resulted. Examination shows that the trusses made a one-quarter revolution as they fell on the downstream side of the piers. They came to rest with the downstream trusses on the river bottom and the upstream trusses more or less directly above, parts near the center of the Illinois span being out of the water. Very little of the 4½-in. concrete-filled floor grating was found. It had been lightly welded to the stringers and thus could have broken free and settled to the bottom of the river.

The theory has been advanced that there was a combination of longitudinal movement and uplift, together with the overturning of the two spans. The condition of the sleeve connections, through which the handrails on the approach and on the collapsed trusses were joined, points to a longitudinal movement; although the sleeves were virtually box sections, the truss handrails on the Illinois side of the river pulled out without bending or damaging either the sleeves or the adjacent railing members. It was reported that a similar pull-out action



Salvage operations started at L0 and continued toward the center of span to provide a clear navigation channel.

occurred on the other side of the r

Also in support of the theor longitudinal movement, as well as tical uplift prior to overturning the condition of the cast steel road expansion devices remaining on adjoining spans. These are of the ventional finger or tooth type, teeth about 18 in. long. They been installed in four sections a the roadway. On the Missouri sid the river, the three downstream tions remained intact, while the fo section was torn off as the s turned over. At the river pier on Illinois side, the downstream se of expansion guard remained in p although it is bent slightly upw The other three sections tore shearing the ¾-in. bolts that had chored them to the approach road slab.

While the condition of the ad ing handrails and roadway expan devices suggest that some longitu movement occurred at each end o two-span continuous truss at the of failure, both movements could have occurred simultaneously. thermore there is no evidence to cate that the truss, as a whole, m longitudinally. It has been sugg that one end of the span could pulled away from its connecting followed by a similar movement a other end.

Other facts developed by recen amination show that virtually no age occurred to the top of the pier on the Illinois side, while west pier showed small amoun spalling and abrasion. Conside spalling occurred at the center the largest of which was a p roughly 12 in. across and 6 in. probably gouged out when the stream top section of the fixed sho it with terrific force. The lower tions of the center pier shoes a place and practically undamaged upstream pin lies on top of the and shows signs of the Lomas having been stripped off. As t rocker bearings at the expansio outer ends of the spans, three of went with the trusses. The one downstream end of the east pie lies on the bearing plates, alth skewed about 45 deg. out of pos in being wrenched from the sole on the bottom chord of the tru 16 connecting bolts were snapp clean.

Most of these facts, it will be

ate to evidence visible above the er. Actually, the principal new information supplied from the salvag- is that the bridge floor broke away m the rest of the structure

Salvage equipment

s would be expected, heavy equipt was needed to dislodge the tan- mass of steel from the riverbed bring it to the surface, after it been dynamited into removable ions. To insure ample lifting equipt and to expedite the work, the eement with the contractor called he U. S. Engineers to furnish their ton derrick boat, the "Hercules," ether with its 5-man crew.

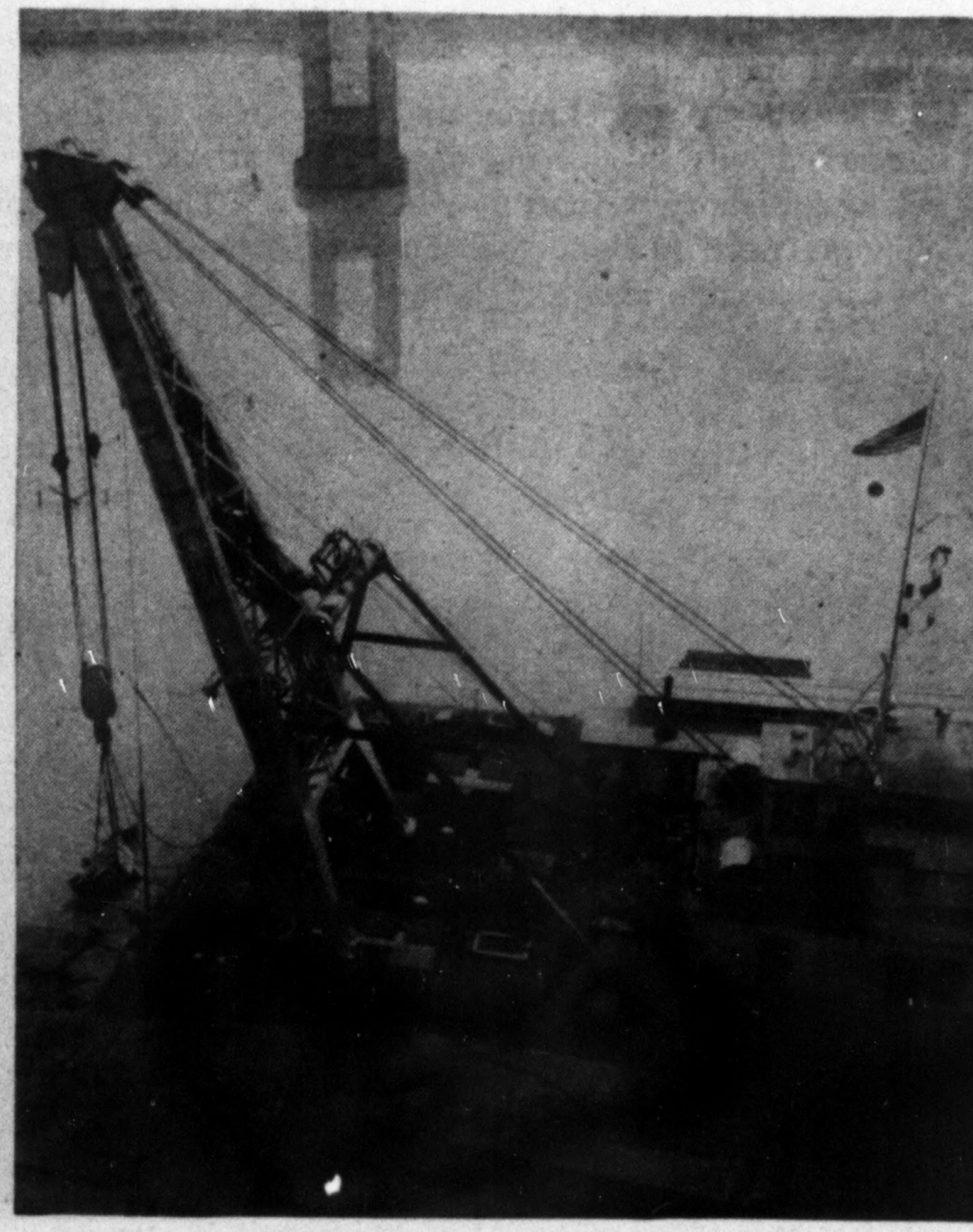
he Hercules, whose keel was laid 940, has an 85-ft. boom mounted a 40x112x8-ft. all-welded steel e. The boom carries a 16-ton r block and an 8-ton upper block ed with 1,640 ft. of 1½-in. steel rope forming a 16-part line. m power is supplied under autoic control and at 125 psi. pressure. he contractor's main equipment ded a 25-ton completely revolv- derrick, with an 85-ft. boom, nted on two 26x110x6½ ft. all- ed steel barges; a 1½ cu. yd. ler crane with a 65-ft. boom having a lifting capacity of 12 tons and securely lashed on the deck of a 26x110x6½ ft. steel barge; and a 50-ton capacity A-frame carrying a 13-part line block and falls operated by a steam hoisting engine and mounted on a steel barge. Both the Hercules and the A-frame lifting barge were well ballasted with water in their rear compartments.

Other equipment on the job included a twin compressor to furnish air to the divers, a 2-way communications line from diver to tender, six 15x40x4-ft. all-welded steel ponton "work flats" and a 250-hp. diesel tow boat for towing salvaged steel to the river bank.

To handle all of this equipment, the contractor used the following crew: 2 construction superintendents, 1 chief engineer, 2 iron-worker foremen, 10 iron workers, 4 power equipment operators, 3 boat operators, 2 deck hands, 3 oilers and firemen, 2 divers, 2 diver-attendants, 1 powder "monkey" and 4 laborers. Although 2 divers were constantly on the job, only one worked at a time. They carried 212 lb. of equipment and leadweights to help steady themselves in the river current.

First operation in removing steel was to anchor the Hercules immediately upstream from the second panel point (L2) of the bottom chord. The 25-ton derrick was anchored in a similar position on the downstream side of the hip joint (U2) of the top chord. With the barges in these positions, a lift was made at L2 and U2, with the hope that the end of one or both trusses could be raised above the water sufficiently to permit burning into sections convenient for removal. But this plan failed. So great was the weight of end rockers and the steel members, framework and floor system in the two 33½-ft. end panels that the truss span bent sharply at the pickup points and no steel could be raised clear of the water.

Slings were released, the trusses settled back into position and the two end panels of the upstream truss were blasted off under water at the original pickup points. While this work was going on, the two other derricks removed all steel visible above water, or any that could be lifted sufficiently to permit burning into lengths short enough to handle. This included mainly the upstream truss between panel point 6 and panel point 9, which marked the end of the salvage contract. The next operation was to re-



...ged steel was loaded on barges by a revolving crane and a crawler crane (left) while the U. S. Army Engineer der- ...oat (right) moved out over the bottom truss chords to do the heavy lifting.

Some idea of the hazards of the work is shown in this action picture of workmen attaching slings preparatory to burning sections for removal.

move all of the upstream truss and as much of the cross-bracing and floor system as possible between panel points 2 and 6.

Since the Army Engineers were concerned only in clearing the channel in the shortest time possible, no attempts were made to salvage any steel in reusable lengths. There were, however, several sections of cords and web members removed in straight lengths up to 30 ft. Whether such members have a salvage value for re-use in other structures is problematical.

The really tough job was to remove the downstream truss, some of which was embedded in sand, particularly towards the end of the job. Th sages that the longer the rem 1,040 ft. of bridge stays in th the more difficult will be its r

Removal of the downstrea progressed from the Illinois ward the center of the first spa Hercules worked along the chord, which lay upstream, a most of the heavy lifting. The A hoist-barge operated directly o the Hercules and along the stream side of the upper cho chief purpose was to snub the masses of steel above waterlin the different members were into convenient lengths.

The 25-ton derrick barge f along close behind the oth barges to pick up members clear of the wreckage and pla on a towing barge, moored The fourth barge, equipped 12-ton capacity crawler cra ceeded immediately in front o frame barge. It also loaded p the wreckage onto a towing b

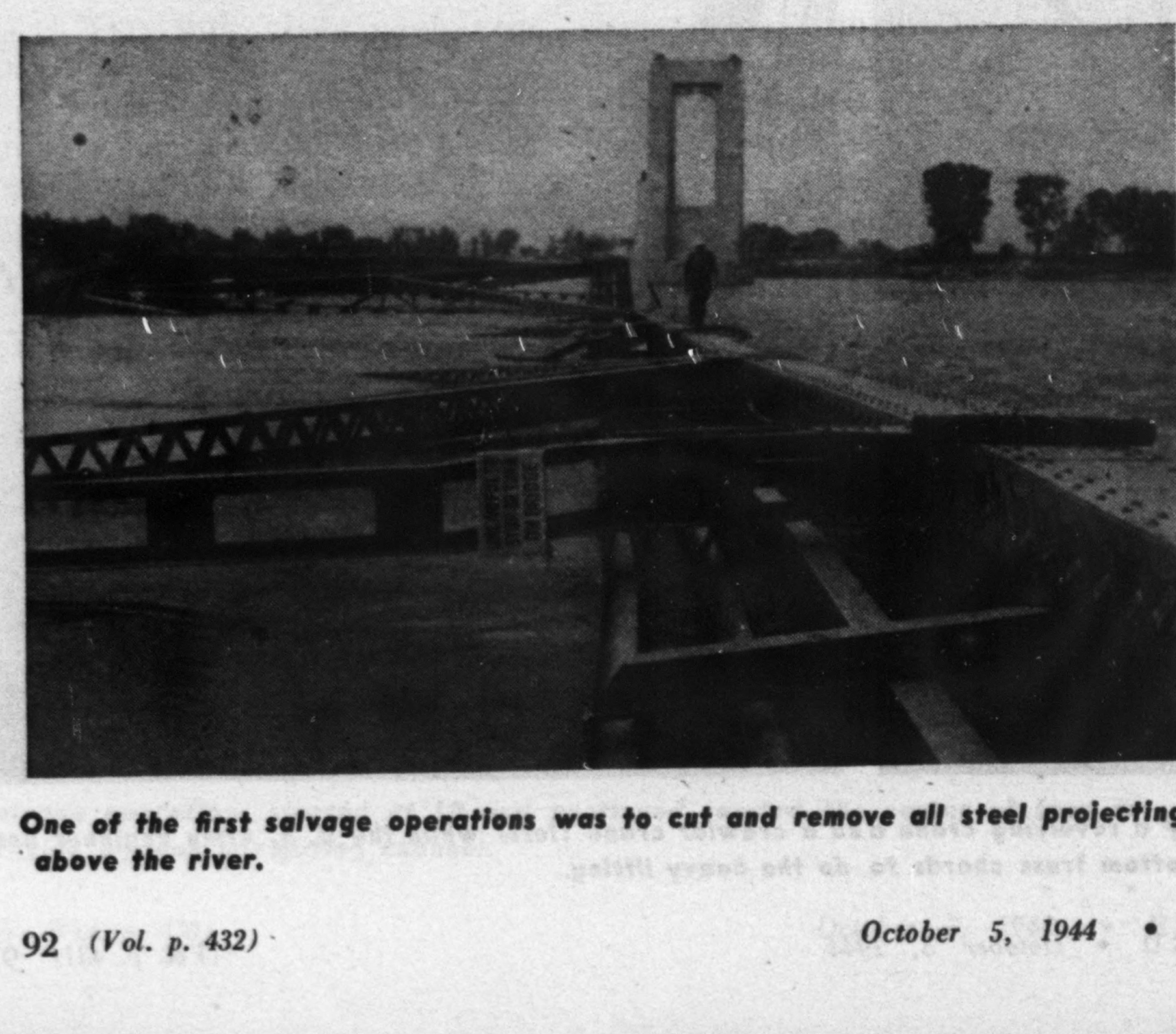
No burning under wate

All steel under water was apart. Burning under water of the question because of visibility in the muddy water because of the danger to w burning apart steel members t under strain. Even above w operators of the oxygen-acety ting torches had to exercise g to avoid serious injury from predictable movement of a st ber burned in two while und vere torque or strain.

In some instances such could be lashed securely to movement. But in others the from a snubbing line or cab ing did not permit of their these instances the torch oper careful to stand clear of th pated movement of the memb cut. Even then he was always to a safety line running to barge in the event the spring steel truss member toppled the water. So carefully was ting of steel planned and that no such accidents occu

Blasted under water at

After a few trial blasti made at the start of salvag tions, it was found best to a trusses at their panel points. eral procedure was to send



One of the first salvage operations was to cut and remove all steel projecting above the river.

wn to place dynamite charges on ch chord member, vertical and diagonal meeting at the joint.

In general, it was not necessary to ast the floorbeams loose and usually was possible to lift them out while tached to the joint of the truss. metimes this took considerable racking and pulling to break the vets in the connections at one end the beam.

In the early stages of the job the ringers were not cut loose from orbeams until they had been hoisted ove water. Later, however, it was und the removal operations could expedited considerably by blasting inger connections free.

Seldom were the dynamited breaks ean at any joint, but the heavy dynate charges demolished it sufficiently permit the tangled steel to be isted above water where the differ- members could be burned off and aded onto the barges.

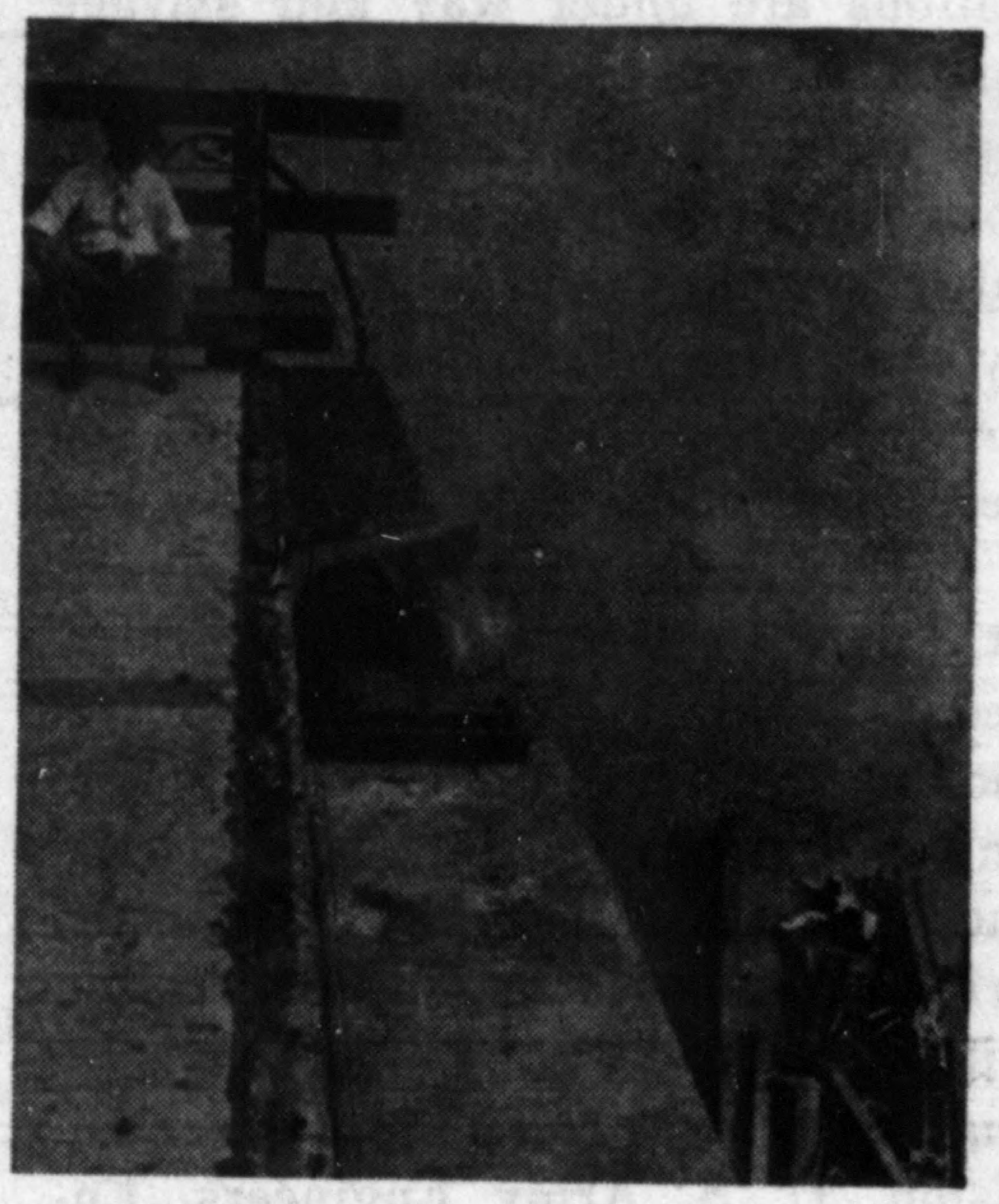
Placing the heavy dynamite charges der water was a dangerous and dish job. Although the river cur- t did not exceed 5 ft. per sec. it set heavy vibrations in the steel and dynamite charges had to be placed total darkness due to the turbidity the water.

High-velocity gelatin dynamite

In blasting the main members apart amite charges made up into cart- ges 5 in. in dia. and 16 in. long containing 80 percent high-veloc- gelatin dynamite were placed di- tly against the members and just side of the gusset plates.

Five dynamite charges were needed ear the heavy top chord sections rt, the heavy of which was made of a 28x$1\frac{1}{8}$-in. top coverplate, two $\frac{11}{16}$-in. side plates and four 6x4x$\frac{5}{8}$- angles. Three charges of dynamite e placed inside of the chord sec- —one against the top coverplate two against the side plate and es lying on the riverbed. The r two charges were placed on top he other side plate and angles.

The bottom chord was open, laced both flanges, and its heaviest sec- was made up of four 7x4x$\frac{1}{2}$-in. es, two 12x$\frac{1}{2}$-in. and two 26x1-in. plates. Only four of the 5-in. dia., n. long, 80 percent high-velocity ine dynamite charges were re- ed to blast the bottom chords in Two of the charges were placed een the chord members and on top of the one lying on the riverbed, and the other two were placed on top of the other side plates and angles. Dynamite charges were held in position with sandbags.



As wrecked steel is loaded on barge (lower right) examination of pier top shows handrail expansion sleeves were not damaged, while some of the roadway expansion device is intact. Also, through the shearing of 16 bolts connecting it to the bottom chord, one expansion rocker remained on top.

Only one dynamite cartridge of the same size as those used on chord members was necessary to demolish the verticals and web members which usually were two channels, laced. A 60 percent high-velocity gelatine dynamite was used to blast these sections apart, the heaviest of which were 18-in. channels weighing 42.7 lb. per ft. The dynamite charge was placed between the two channels and held in place with a sandbag. A similar blasting charge was used on the stringers and other cord members made up of plates and angles.

All chord members were silicon steel. Web members, stringers and floorbeams were carbon steel.

At some of the panel points 5 members were torn apart at the same time, using 13 dynamite charges. All were fired simultaneously with a "primer cord" fuse, which in turn was fired with an ordinary electric blasting cap connected to a long insulated duplex cord running to a hand-operated blasting machine.

Attaching the $1\frac{3}{4}$-in. steel wire rope sling from the hoisting cable around sections of steel to be removed from the murky river was a tedious and

A close-up of a truss joint shows the effect of marine dynamiting.

laborious job. Working in total darkness, usually using one hand, the diver would guide the sling down on one side of the steel to be removed. With the sling hanging vertically beside the steel to be removed, a ¾-in. rope was passed under the steel and up to a barge located on the other side of the member. A firm pull on the rope bent the sling under the steel and up on the other side of the piece.

The rope was then passed over the steel to a barge located on the other side of the member, and pulled tight to completely encircle the piece of steel. With the loop thus completed a shackle attached to the free end of the sling was threaded around the lifting cable and closed with a large cotter key which was locked with a bolt that operated as a cotter pin.

Removal of the remainder of the 670-ft. span on the Illinois side of the river will be executed by the St. Louis Engineer District, U. S. Army. Negotiations are under way and salvage operations will be resumed soon. This will restore the full use of one clear span for navigation. Removal of the other span can then be accomplished by the Chester Toll Bridge Commission whenever it is able to secure the necessary funds.

Col. L. B. Feagin, district engineer, St. Louis District, U. S. Army Engineers, assumed direct charge of removing the 300 ft. of collapsed bridge on the Illinois side of the river. He issued all navigation orders past the bridge site and acted in cooperation with Col. Malcolm Elliott, division engineer, Upper Mississippi River Division, U. S. Army Engineers. Enforcement of navigation orders was by the U. S. Coast Guard, under Capt. Beckwith Jordan, assistant district coast guard officer.

Other employees of the U. S. Army Engineers connected with salvaging operations included: A. A. McFadden, engineer in charge of service base, and river and harbor projects; Capt. J. A. Thieson, of the derrick barge, the "Hercules"; Ruddle J. Spring and Harry Grieshaber, civilian tow boat pilots, and W. W. Hitt, inspector on river construction.

The contract for removing the 300 ft. of structure, estimated to cost $50,000, was held by the Massman Construction Co., Kansas City, Mo., constructors of the original bridge. (*ENR*, Mar. 19, 1942, vol. p. 446). The contractor's supervisors on the job included: W. H. O'Donley, general superintendent; W. C. Koontz, construction superintendent; and John N. Newell, chief engineer.

Sverdrup and Parcel, consulting engineers who made the original design of the bridge were represented on the job by R. D. Bane, field engineer.

C. W. Scott is manager and John File is acting chairman of the Chester Toll Bridge Commission.

Large Spud Fabricated of Timber

Massive size combined with strength has been achieved in the huge spud of laminated wood manufactured for a dredge used on the Columbia River by the General Construction Co. of Seattle. The spud is 85 ft. long, 30x30 in. in cross section and weighs, dressed to net size, about 19,200 lb.

In fabrication, 10,345 fbm. of kiln dried lumber and 320 lb. of urea cold-setting resin glue were used. The laminations are 2-in. rough stock dressed to 1⅝ in. net, of random width.

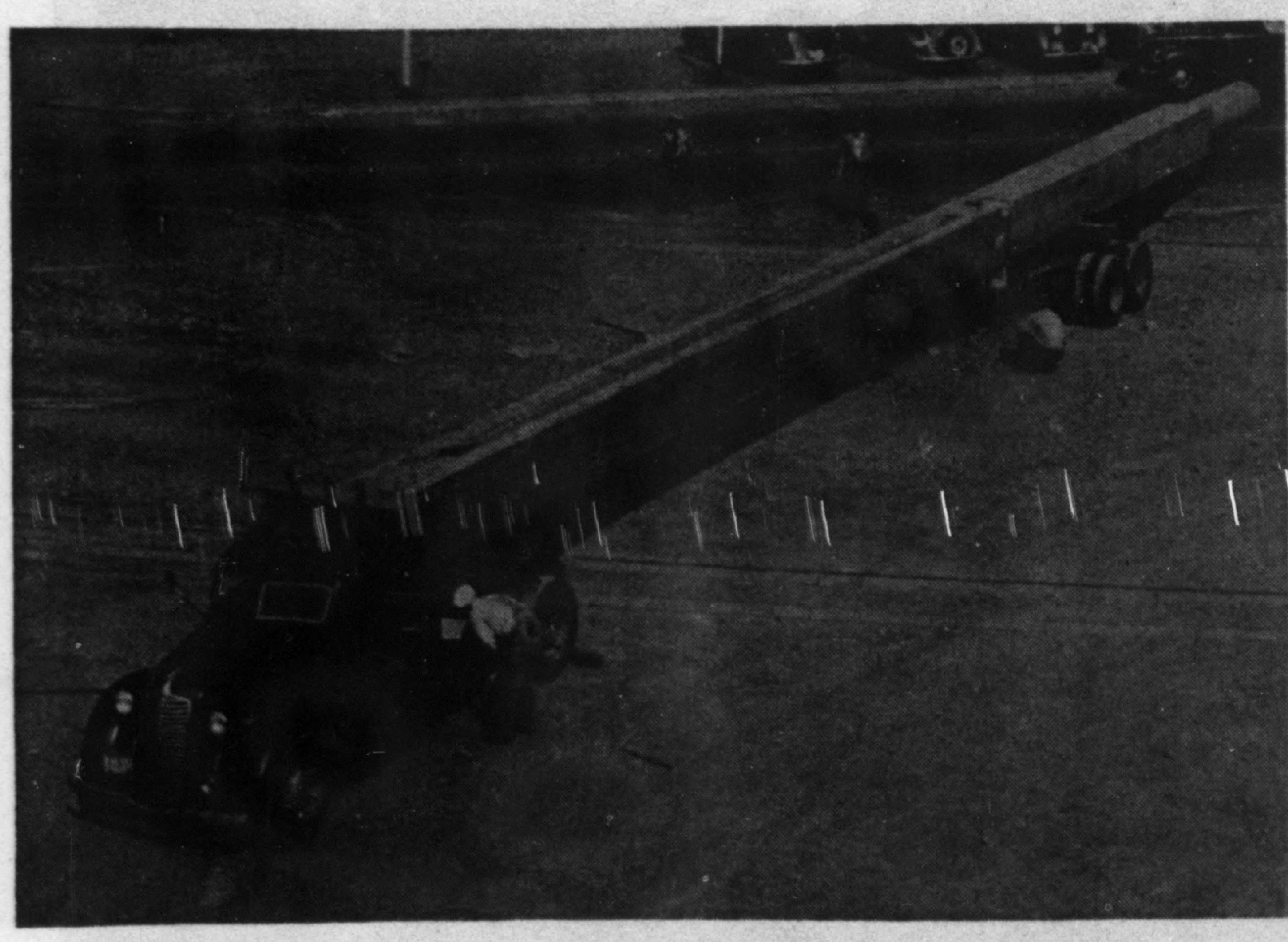
The pieces in the spud were laid out one lamination at a time and one upon the other. All edges were coated with fresh glue. Pressure was applied by means of clamps both vertically and horizontally, and was retained until sufficient time had elapsed for the glue to set properly. No nails were used in the timber.

At one end the timber was rounded off by hand tools to fit it inside a steel spud point necessary to protect the bottom end of the stick in contact with the river bottom. A long vertical groove, starting at the top of the timber and running down one side about 36 ft. was tooled to the proper width and depth to take a heavy railroad rail that was used as a sliding guide for the timber while in use on the dredge.

When the clamps that held the timber as it was being laid up were removed, the timber was moved to the yard by means of two lumber carriers, one near each end. It was placed on a truck and trailer with two lumber stackers and then hauled to the water front.

The truck was backed down to the water's edge and bindings were cut loose, allowing the timber to slide down the rollers on the truck into the river, where it was towed to the site of the dredge. It was placed in the spud channel of the dredge by means of a block and tackle applied at one end, which raised it directly out of the water and stood it on end in its channel.

Timber Structures, Inc., Portland Ore., was the fabricator.



This 19,200-lb., 85-ft. long timber spud fabricated for use on a Columbia River dredge was transported overland by truck.