

# **HYDRAULIC BUNDLE EXTRACTOR**

**16 hrs.**

A mechanical apparatus, weighing 14,000#, hydraulically operated with an air motor as a power source. Crane lifted into position and butt-clamped onto the shell flange of the exchanger stripped for bundle removal. The extractor is capable of pull forces in excess of 189,000#. Held in position by the crane, the bundle is dragged out of its shell. It is then lowered to the ground, the bundle removed from the cradle and transported out of the area.

## **TERMINAL OBJECTIVE**

Learner will understand hazards of operation of a crane suspended hydraulic bundle extractor, and demonstrate safe set-up and operating procedures to be employed.

## **ENABLING OBJECTIVES (PULL BUNDLE)**

Learner will collect all needed equipment  
Demonstrate pre-start inspections (incl. lube & proper operation)  
Demonstrate jobsite preparation, incl. unit work clearance  
Demonstrate safe removal of channel head and related piping  
Demonstrate proper hook-up to crane  
Demonstrate safe connection of bundle puller to bundle shell and tubesheet  
Demonstrate smoothness of operation with min. binding  
Adjust crane hook and boom as necessary  
Properly adjust dollies of puller to support weight of bundle  
Balance bundle on cradle with leveling rams  
Disconnect puller from shell and safely signal crane to lower it to the ground  
Secure any loose handrails  
Safely remove bundle from puller and prepare it for transport  
Secure all gear in a safe manner

## **ENABLING OBJECTIVES (STUFF BUNDLE)**

Learner will collect all needed equipment  
Demonstrate pre-start inspections (incl. lube & proper operation)  
Demonstrate jobsite preparation, incl. unit work clearance  
Demonstrate safe loading of bundle onto cradle & level prior to lifting w/crane  
Demonstrate proper hook-up to crane  
Demonstrate safe connection of bundle puller to bundle shell  
Demonstrate smoothness of operation to stuff bundle with min. binding  
Adjust crane hook and boom as necessary  
Properly adjust dollies of puller as required  
Safely level bundle in its shell  
Level puller and disconnect it from the shell  
Safely signal crane to lower puller to the ground  
Secure any hand rails and all gear in a safe manner  
Safely replace channel head and related piping

## **TEACHING/LEARNING ACTIVITIES (PULL BUNDLE)**

Although this training can be done in a mock job situation, there is no substitute for on the job experience

Study and discuss training manuals in the classroom

Examine the extractor and its basic components, attachments, and required equipment

Perform pre-start inspections, lube & operation of functions

Perform job walk, make note of any obstacles, decide on procedure to be followed, acquire unit work clearance

Transport bundle extractor and associated gear to the jobsite

Set up the crane at the jobsite and spot the extractor

Connect the extractor to the bundle shell and tubesheet

Remove the bundle from its shell and send to the ground

Secure any loose or removed handrails, leave bundle deck in safe condition

Remove the bundle from the sled, set on jacks for transport

Secure all gear in a safe manner

## **TEACHING/LEARNING ACTIVITIES (STUFF BUNDLE)**

Perform pre-start inspection of the bundle puller and related equipment (lube & operation)

Perform job walk and obtain unit work clearance

Collect all needed equipment

Transport the bundle puller if necessary

Set up crane & spot the puller

Spot the bundle

Properly set the bundle on the cradle & level

Hook up the crane to the puller, lift & level

Lift puller & connect to the shell

Safely stuff the bundle in its shell

Level the bundle in its shell

Level puller, disconnect from shell and send it to the ground

Secure handrails & all gear in a safe manner

Replace channel head & related piping

Clean area up of all rigging and sign off unit work clearance

## **EVALUATION**

Learner must pass a written exam with no less than 80%

Learner will be given a performance test to fulfill the requirements of enabling objectives listed. 90% is passing on an evaluation checklist

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## PREPARED PAPERS

### 1. Refinery Experience With The Hydraulic Tube-Bundle Extractor

**WARD BECKCOM** — Maintenance Superintendent, Beaumont refinery, Mobil Oil Corporation, Beaumont, Texas. He received his B.S. degree in mechanical engineering from Lamar State College of Technology in 1954 and joined the Magnolia Petroleum Company as a Junior Engineer in the engineering department of the Beaumont refinery. He has held several engineering positions in the engineering department, including the position of technical supervisor. He has had experience in the maintenance field including corrosion inspection and control, engineering design and construction, maintenance of process units and rotating equipment and maintenance planning and administration. He assumed his present position in March 1971.



#### Abstract

Removal of exchanger tube-bundles up to 66 inches in diameter at Mobil Beaumont utilizing a hydraulic extractor device is safer, faster and consumes less manpower than conventional rigging methods.

The mechanical apparatus, weighing 7 tons itself and capable of pull forces in excess of 500,000 pounds, is crane lifted into position and butt-clamped onto the shell flange of the exchanger stripped for bundle removal. Held in position by the crane and balanced by the extractor's leveling cradle, the bundle is dragged out of its shell with pull rod attachments by hydraulic forces reacting on the shell flange.

Discussion and description of this useful maintenance tool are supported by movie film illustration featuring actual field episodes employing the device to pull and re-install a large tube-bundle at Mobil's Beaumont refinery.

#### Introduction

Mobil Oil Corp.'s 100 million dollar Beaumont refinery modernization project completed in the late 1960's not only

replaced obsolete facilities and rearranged processing schemes, but it also modernized some long standing maintenance techniques. Namely, maintenance handling of the familiar tube and shell heat exchangers. No longer do you see the large overhead structures and gantries that once cluttered the locations of the tube and shell exchangers at the Texas plant. Substituting for these costly and cumbersome structures is a relatively simple, self-contained device called a Hydraulic tube-bundle extractor.

The mechanical apparatus, capable of horizontal pull forces of several hundred-thousand pounds, is crane-lifted into position and butt-clamped onto the shell flange of the exchanger stripped for bundle removal. Held in position by the crane and balanced by the extractor's leveling cradle, the tube bundle is dragged out of its shell with pull rod attachments by hydraulic forces reacting on the shell flange.

#### Payout and other benefits

Direct payout for the initial investment in this piece of specialized equipment lies in three basic areas: (1) re-

duction of capital investment and maintenance expense associated with alternate methods of bundle removal (structures, horizontal pull points, etc.). (2) reduction of maintenance manpower over alternate methods by approximately 50% and (3) reduction of stream time loss with the faster specialized equipment method (nominal time to pull any bundle regardless of size or force required is 20 to 30 minutes).

Beyond direct payout and of greatest importance is the relative safety of the device. In comparison to the usually awkward saddle slings, winch-truck rigging and sheave blocks, the extractor is a big improvement with regard to minimizing hazardous exposure to personnel. Jobs are completed quickly and performed with exceptional safety in spite of extraction force capability approaching 700,000 pounds.

#### Basic parts of extractor

The basic parts of the extractor and the functions they perform are described in the following and illustrated in Figure 1.

##### Item Description/Discussion

1. **Main Frame**—Contains main butt plates 1A.

3. **Main Superstructure**—Contains four tension arms 3A.

6. **Cylinder Car**—Contains main cylinder and chain motors. Carriage located atop main members of extractor and is equipped with air operated lugs on the underside. The carriage can be moved the length of the extractor by means of the main cylinder pushing the carriage back after the bundle has been pulled the length of the rod and by means of the chain connected to the hydraulic motors under the car.

7. **Main Cylinder**—The main cylinder (primary force applicator) is located on the car 6 and is the cylinder used when pulling a bundle. The cylinder has a pulling force of 113,000 pounds with a hydraulic pressure of 3,000 psi applied to the rod end of the piston and a pushing force of 150,000 pounds when a hydraulic pressure of 3,000 psi is applied to the piston end. The ratio of hydraulic pressure to pulling force is 37.8 to 1. (Example—If we have 1,000 psi on the hydraulic gauge, then we have a pulling force of 37,800 pounds being exerted by the main cylinder.)

8. **Drive Chain**—Secondary force applicator.

9. **Front Clamps & Cylinders**—The front clamp cylinders are located inside the 12 in. × 6 in. tubing that are the main members of the extractor. The cylinders are connected to the front clamps that grip the shell flange of the exchanger during pulling and installing bundles. The two cylinders are operated by one common valve in the block of operating valves. The cylinders are capable of extending the front clamps out a distance of approximately 40 inches.

10. **Sling or Securing Cylinders**—The securing cylinders are located at the front on the main members of the extractors. The cylinders are equipped with a cable sling and are used to secure the front of the extractor to the shell of the exchanger by placing a bolt through the eye

of the sling and through one of the bolt holes in the shell flange. The front of the extractor can be pulled up firmly against the tube sheet of the bundle before pulling operations begin. The slings are loosened after the bundle has been pulled but not completely removed or until the extractor has been brought to balance.

11. **Operating Valves**—This block of valves operate all the hydraulic cylinders on the extractor. These are three-position spring-return valves. Pushing forward and pulling backward opens the ports on the valve. Once released they are spring-returned to the neutral position which allows the oil to return to the oil reservoir. Each valve will be labeled as to which cylinders they control on the puller.

15. **Balance Cylinders**—The balance cylinders are located on the outer members of the extractors. These cylinders, too, are controlled by one common valve in the block of operating valves. The purpose of the balance cylinders is to balance the extractor and bundle after it has been pulled or to balance extractor and bundle before lifting to install a bundle. The cylinders are connected to a member with lugs that pin to the overhead structure. By moving the balance members toward the heavy end of the extractor, it can be brought to the level position before the load is raised or lowered.

18. **Reaction Lugs**—Air cylinder operated using air valve 26A.

19. **Hydraulic Motors**—Car positioner and secondary force applicator. The hydraulic motors are located under the cylinder car 6 and are controlled by one common valve in the block of operating valves. The motors are capable of rotating in both directions. The motors pull the chain that is connected to the underside of the carriage. The carriage is moved forward and backward by the use of the hydraulic motors. Small and easily pulled bundles can be pulled with the hydraulic motors; however, it is recommended that the first pull be made with the main cylinder until the rod has made its full stroke and it is determined the pull pressure required is 1,000 psi or less on the hydraulic gauge.

21. **Hydraulic Pumps**—The hydraulic pumps are powered by the air motor. The first pump from the air motor has a capacity of 22 gpm and a pressure output of 1,000 psi. The second pump has a capacity of 13 gpm and a pressure output of 3,000 psi. When pumping at a pressure less than 1,000 psi, both pumps are operating with a capacity of 35 gmp. When the pressure exceeds 1,000 psi, the first pump (or volume pump) is relieved to the oil reservoir tanks by means of a pressure control valve located in the discharge line. Once the pressure has exceeded 1,000 psi the check valve located in the discharge manifold piping from the tandem pump seats and maintains the pressure to the operating valves. It is easy to see that all hydraulic cylinders will operate faster with a pressure of less than 1,000 psi since the speed of the cylinders depends on how fast their volume can be displaced.

23. **Air Motor**—The air motor is powered by the plant air system. A rubber hose is to be connected from the

plant air system to the extractor air piping at a connection located next to the operating valves.

**26 Reaction Lug Lifting Cylinders**—The lug lifting cylinders are air operated and are located under the car 6 of the main cylinder. The cylinders are operated by a two-piston hand level valve operated near the block of operating valves. The cylinders are piped so that when the front lugs are down the rear lugs are up and visa versa. The front lugs must be in the down position when pulling with the main cylinder and at anytime the car 6 is to be moved toward the back of the extractor. The back lugs must be down to push with the main cylinder and at anytime the carriage is to be moved toward the front of the extractor. Particular attention should be taken as to what position the lugs are in before moving the car.

### Operation of extractor

The following major steps must be completed prior to beginning removal of tube bundle from the stripped exchanger:

1. Extractor lifted and leveled.
2. Butt plates positioned on shell flange.
3. Sling cylinders are connected to shell flange and extractor is centered.
4. Extractor is clamped to shell flange.
5. Car is moved forward and front lugs are engaged on lug blocks.
6. Motor bypass valve is open.
7. Main cylinder rod is extended and secured to tube sheet.
8. Extractor is level and crane cables are vertical over load.

We are now ready to exert a pulling force on the tube bundle. There are two methods used to apply the force slowly to break the bundle loose from the shell. One method is to just pull the main cylinder valve handle slowly and gradually apply the force while the air motor is running full speed. The other method is to reduce the speed of the air motor, pull the main cylinder valve open, then gradually increase the speed of the air motor.

Either method is satisfactory, but it would be emphasized that during the initial break the force should be

applied slowly. Once the tube sheet is free of the shell flange, any speed desired may be used to move the bundle onto the extractor. When the main cylinder is completely retracted, the adjustable "V" blocks are jacked inward to take the load of the tube sheet. During the initial pull the tube sheet passes over the "V" block dollies until it can be loaded onto the dolly nearest the main cylinder car.

At this point further extraction of the bundle may be accomplished by the method of backstepping the car or by engaging the chain motors. If the bundle has moved relatively freely, the force of the chain motors may be sufficient to continue movement. To engage the motors, close the motor bypass valve, then actuate the proper control handle to try to continue extraction of the bundle. Since the chain is a continuous motion and much faster, it is desirable to use this method as much as possible.

When the bundle has been completely removed from the shell, the next step is to determine the balance point of the unit. This is done by releasing gradually the front clamps until they are free and can be rolled down or out.

**CAUTION:** Do not disconnect cable slings from shell flange until the unit is in balance. When the flange clamps are released, notice whether the front of the extractor tries to move up or down. If it moves down and puts additional tension on the cable slings, the balance arms need to be brought forward. If the front tries to go up, this indicates the back is heavy; therefore, the balance arms need to be moved back. This entire operation of balancing is performed with the cable slings attached to the shell flange.

**CAUTION:** Do not disconnect the cable slings until the front end of the extractor can be moved freely by one man. This step is a safety procedure that prevents the sudden shifting of the front of the extractor. When the front can be moved freely, disconnect the cable slings; and the unit is ready to set on the ground for unloading.

The following discussion relates to the details and procedures for installing exchanger tube bundles with the extractor:

The extractor is sitting on the ground or platform.



Move the main cylinder car to the back of the extractor to permit placing the bundle on the "V" block dollies. Locate the dollies along the extractor to support the front tube sheet, a middle baffle on large bundles and the next to the end baffle. Since the baffles are a smaller diameter than the tube sheet, place pieces of wooden 2 in. x 4 in. or 4 in. x 4 in. blocks to raise the floating tube sheet or first baffle above the butt plate "V" shapes on the frame. The floating head or first baffle should clear the top of the "V" shapes at least the width of the gasket. In most instances a safe dimension is 1 in.

Next fasten the pull plate to the tube sheet to prevent the bundle from rolling off the extractor should the front end go down for any reason. The unit is ready to balance by lifting slowly and moving the balance arms until the unit is level. Now lift the unit to the shell and fasten the side cylinder slings to the shell flange. Do not extend the sling cylinders more than 6 in. or half their stroke. When the slings are connected, actuate the main cylinder to start the floating head or first baffle into the shell. Once the bundle is started, then the front clamps can be rolled up and pulled against the back side of the shell flange to

clamp the unit in position.

At this point the chain drive units should be capable of pushing the bundle into the shell. Make sure the front car lugs are up before actuating the chain drive motors. As the bundle is being installed the crane may have to raise or lower the unit and move it sideways as the baffles enter the shell. When the bundle is in place, the same procedure is used in unclamping, balancing and then removing the side cylinder slings.

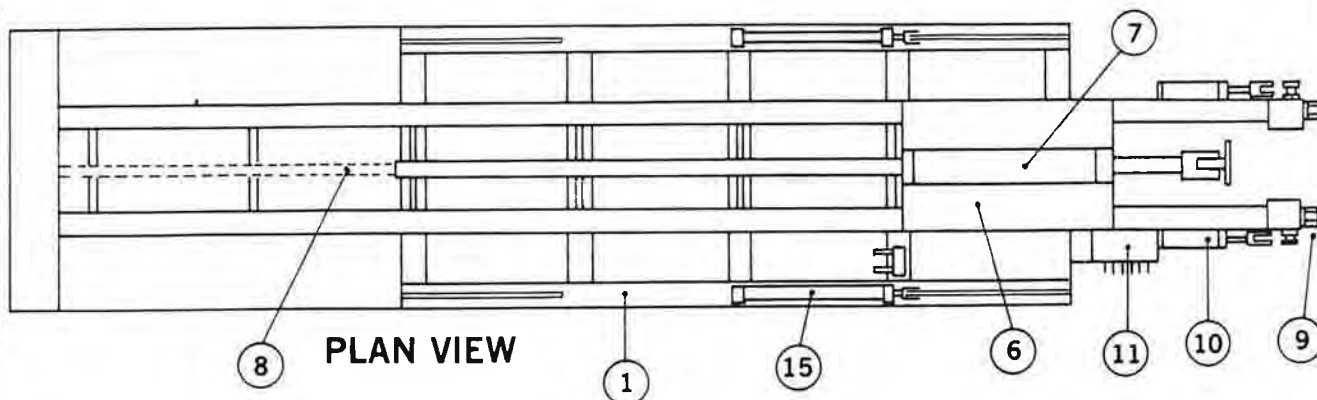
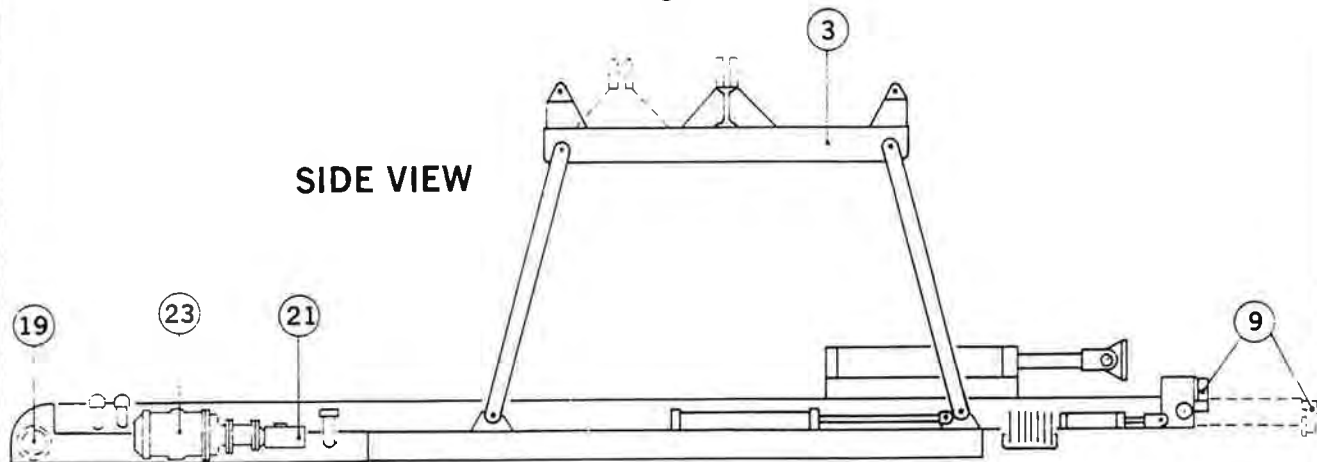
#### **Tube-bundle extractor cost**

The cost of this specialized piece of equipment varies with size requirements for the unit and may also be influenced by special accessory systems to provide higher levels of horizontal pull force. Cost order of magnitude is \$40M to \$60M. The unit described herein is a Model 504, available in standard or customized design through: Hydro-Extractors, Inc., P.O. Box 636, Vidor, Texas, phones 713-769-2473 and 713-769-7411. A somewhat similar specialized tool called a "Bundle Wagon" is custom made for buyers through M&H Manufacturing Corp., also a Vidor, Texas, firm: 710 South Street, phone 713-769-6996.

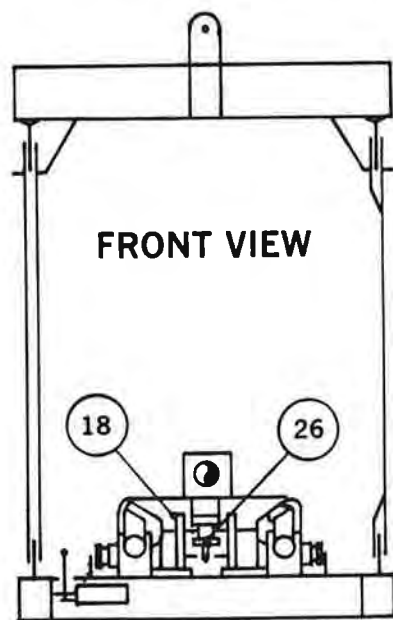


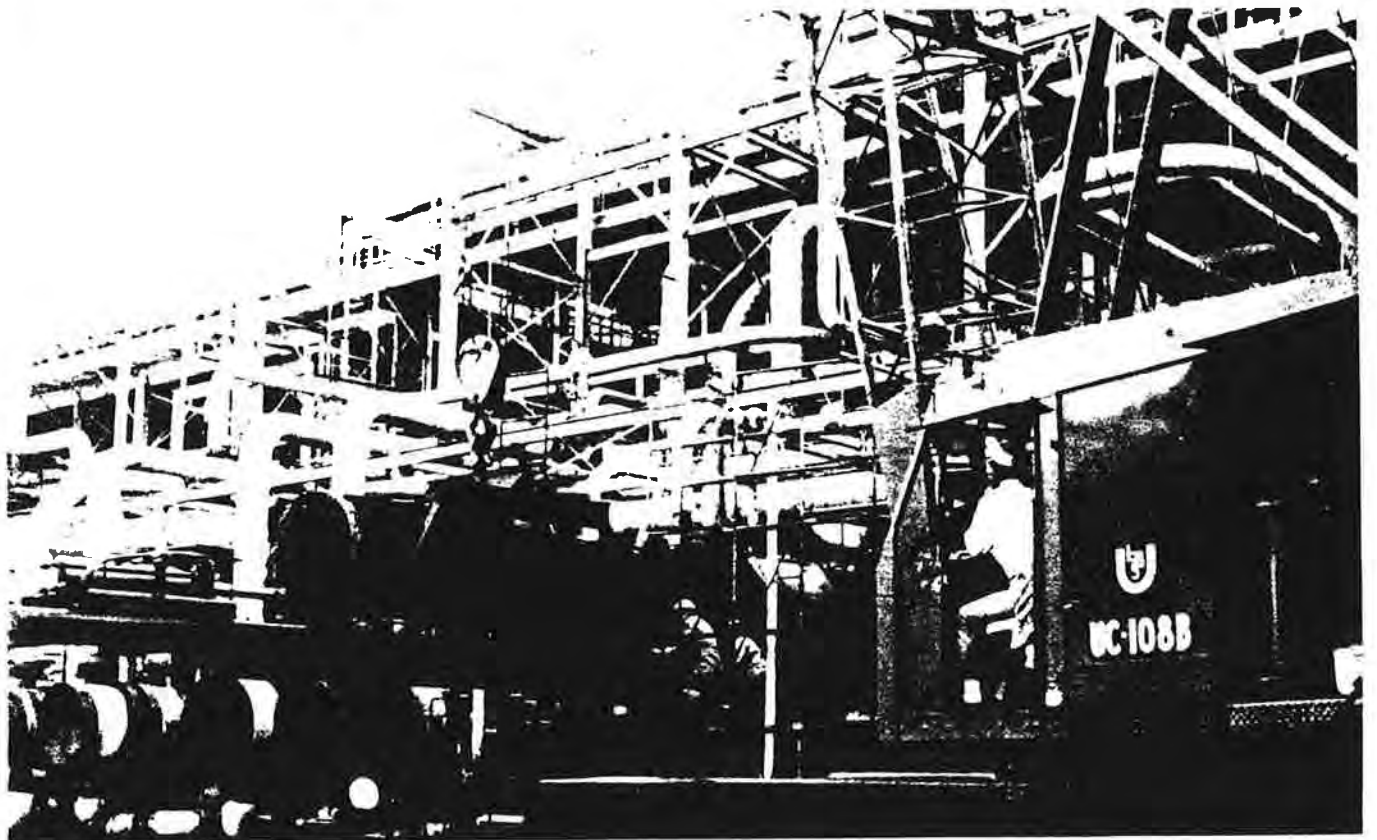
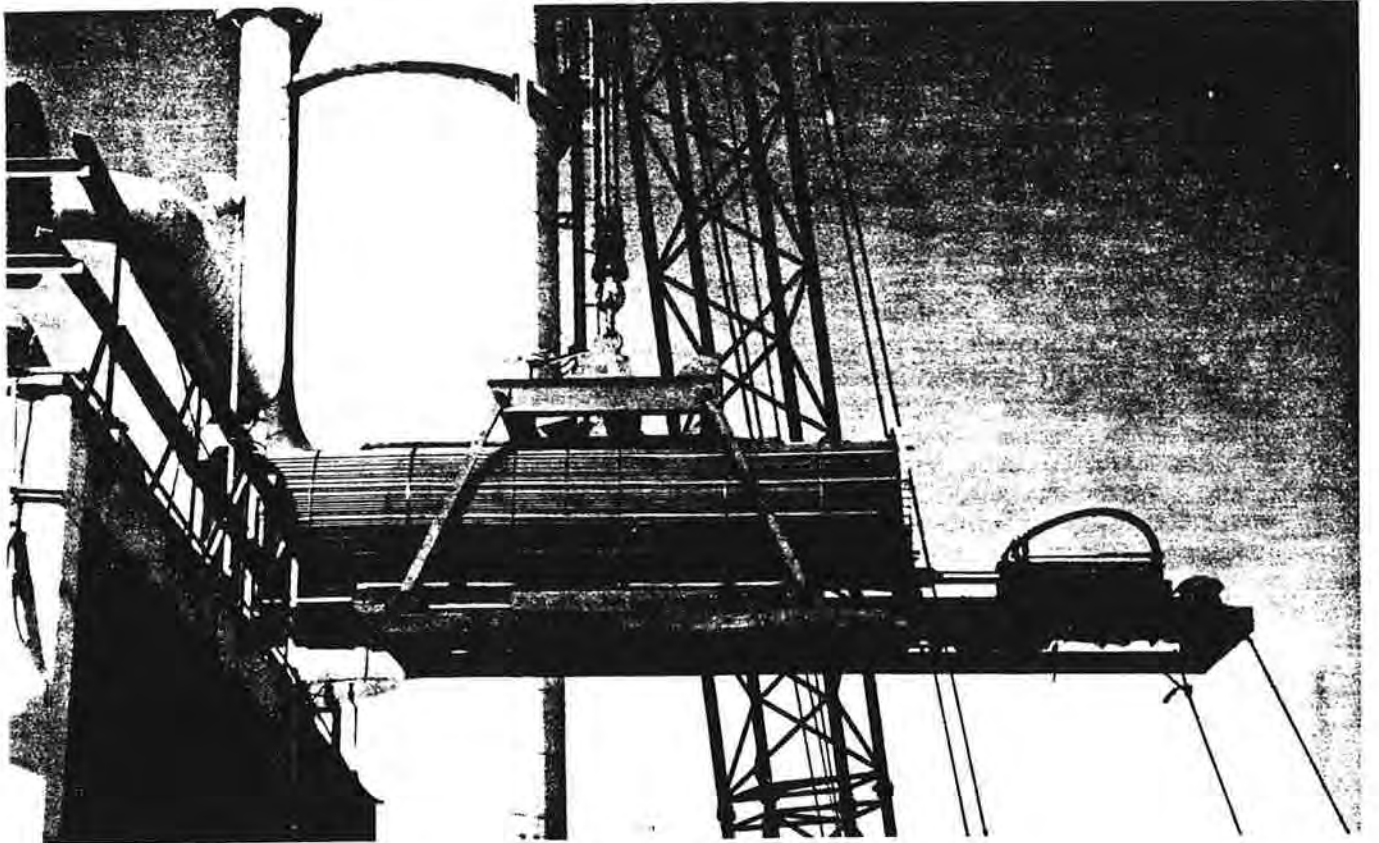
# Hydraulic tube-bundle extractor

Fig. 1

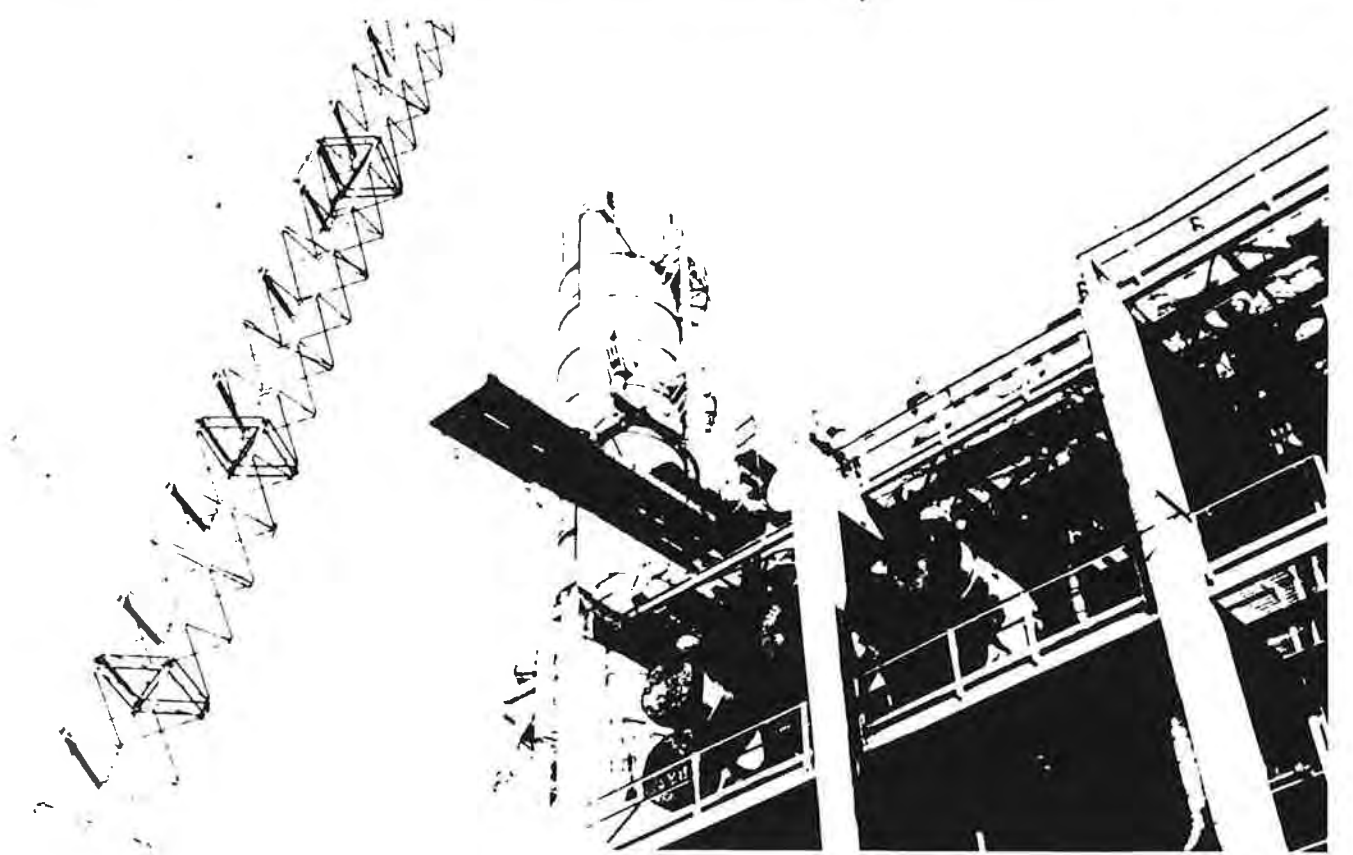
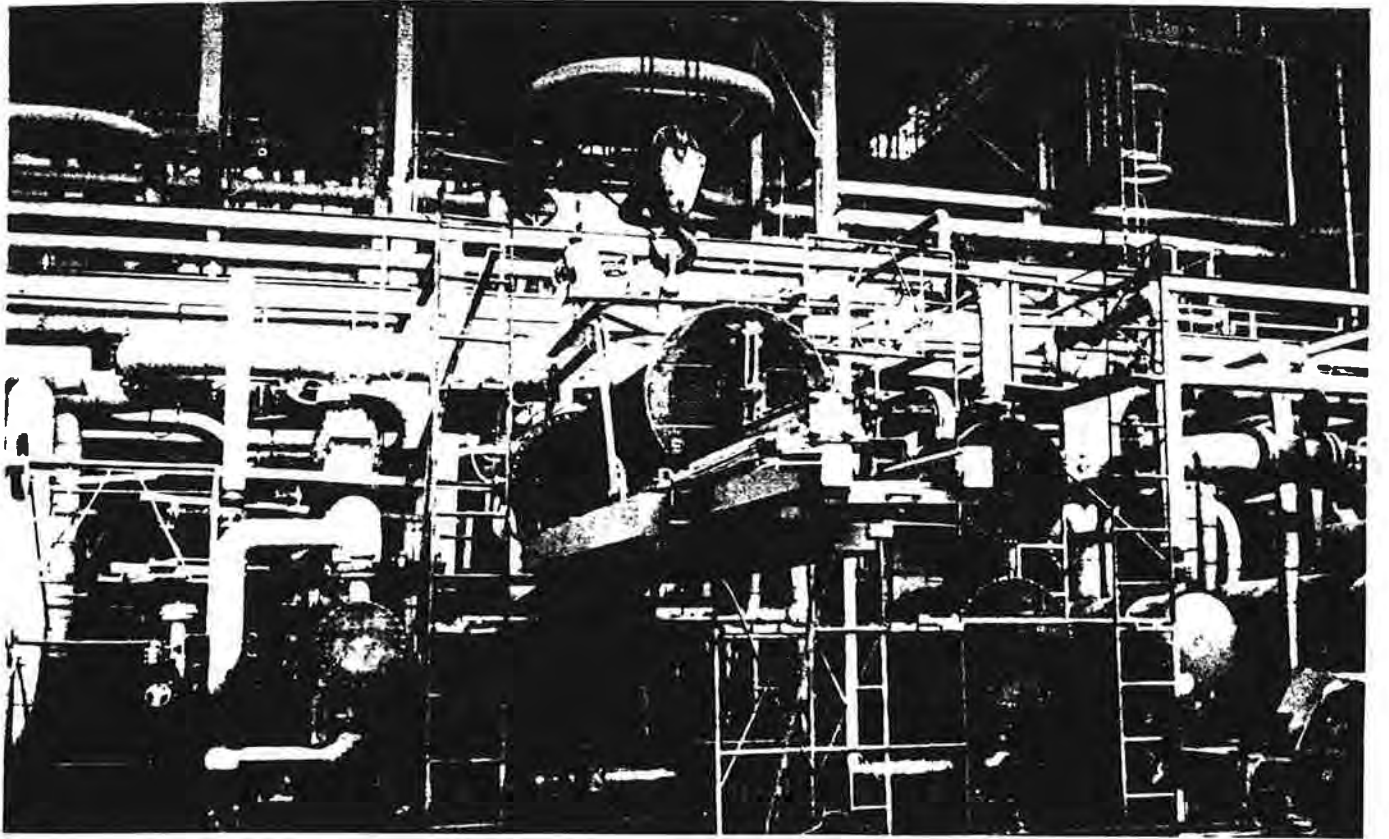


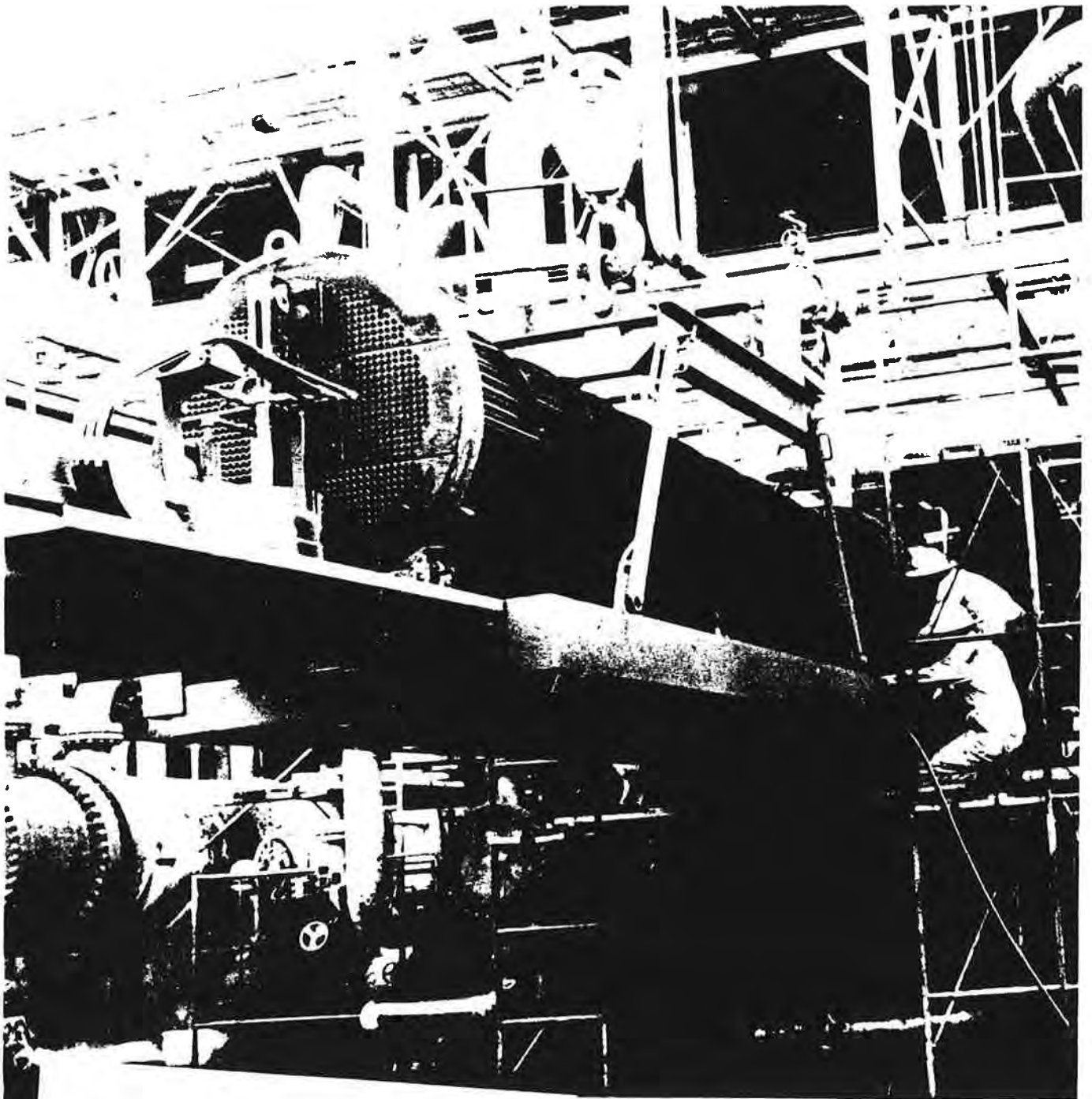
Item No.		Legend	
3	Main superstructure	8	Drive chain
9	Flange clamp	9	Flange clamp
19	Hydraulic motors	10	Sling cylinders
21	Tandem pumps	11	Hydraulic control valves
23	Air motor	15	Balance cylinders
1	Main frame	18	Reaction lugs
6	Cylinder main car	26	Air cylinder for reaction lugs
7	Main cylinder		











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**HYDRAULIC BUNDLE EXTRACTOR  
PERFORMANCE EVALUATION  
(PULL BUNDLE)**

- \_\_\_ Collect all needed equipment
- \_\_\_ Pre-start inspections (lube & proper operation)
- \_\_\_ Jobsite preparation
- \_\_\_ Safe removal of channel head & piping
- \_\_\_ Proper hook-up of puller to crane
- \_\_\_ Safe connection of bundle puller to bundle shell and tubesheet
- \_\_\_ Smoothness of operation with minimum of binding in shell
- \_\_\_ Properly adjust crane hook and boom as needed
- \_\_\_ Adjust dollies as needed and properly crib
- \_\_\_ Balance bundle on cradle
- \_\_\_ Disconnect puller from shell and safely signal crane to lower to ground
- \_\_\_ Secure any hand rails
- \_\_\_ Safely remove bundle from puller and set on jacks for transport
- \_\_\_ Secure all puller related gear in a safe and organized manner

Name \_\_\_\_\_

Date \_\_\_\_\_

Instructor \_\_\_\_\_

**HYDRAULIC BUNDLE EXTRACTOR  
PERFORMANCE EVALUATION  
(STUFF BUNDLE)**

- \_\_\_\_\_ Collect all needed equipment
- \_\_\_\_\_ Pre-start inspections (lube & operational)
- \_\_\_\_\_ Jobsite preparation including unit work clearance
- \_\_\_\_\_ Safe loading of bundle onto cradle & level prior to lifting
- \_\_\_\_\_ Proper hook-up to crane
- \_\_\_\_\_ Safe connection of bundle puller to bundle shell
- \_\_\_\_\_ Smoothness of operation to stuff bundle
- \_\_\_\_\_ Adjust crane hook and boom as necessary
- \_\_\_\_\_ Properly adjust dollies as required
- \_\_\_\_\_ Safely level bundle in its shell
- \_\_\_\_\_ Level puller and disconnect it from the shell
- \_\_\_\_\_ Safely signal crane to lower puller to the ground
- \_\_\_\_\_ Secure any hand rails and all gear in a safe manner
- \_\_\_\_\_ Safely replace channel head and related piping
- \_\_\_\_\_ Secure all puller related gear in a safe and organized manner

Name \_\_\_\_\_

Date \_\_\_\_\_

Instructor \_\_\_\_\_