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Approved by

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Q.A. Manager

**INSTALLATION AND REMOVAL CART  
OPERATION MANUAL**

**CENTRAL RESEARCH LABORATORIES**

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A  **DOVER** DIVERSIFIED COMPANY

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## I. GENERAL DESCRIPTION

The installation and removal cart is designed to be a multipurpose system which can be used for installation and removal of several models of Central Research Laboratories (CRL) manipulators. The system can be used for the Model G, G-HD, G-HDE, 8, E, **E-HD**, F, L, and L-HD manipulators. The system consists of a lift table assembly and a transportation cart assembly (Fig. 1).

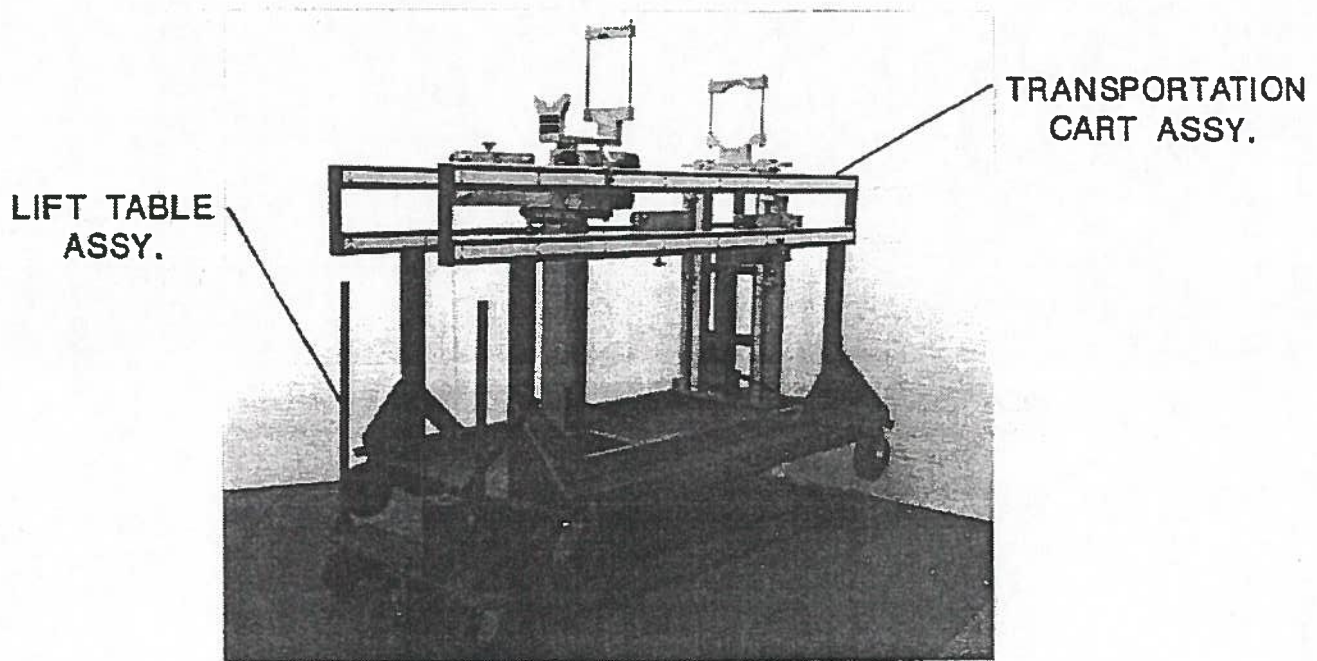


FIG. 1

### A. D-32855 Transportation Cart

The transportation cart assembly has a master and slave hand-operated hydraulic lifting jack assembly mounted on the cart (Fig. 2).

The master and slave jacks are supported on a carriage so they can move along the longitudinal length of the cart to facilitate the installation and removal of the manipulator. Each jack also has lateral motion travel to make it easier to line up the manipulator during installation or removal. Each jack is hand operated and has a lift range of 18.75 inches (475 mm). The jack assemblies are equipped with hand-operated locks for both longitudinal and lateral motions.

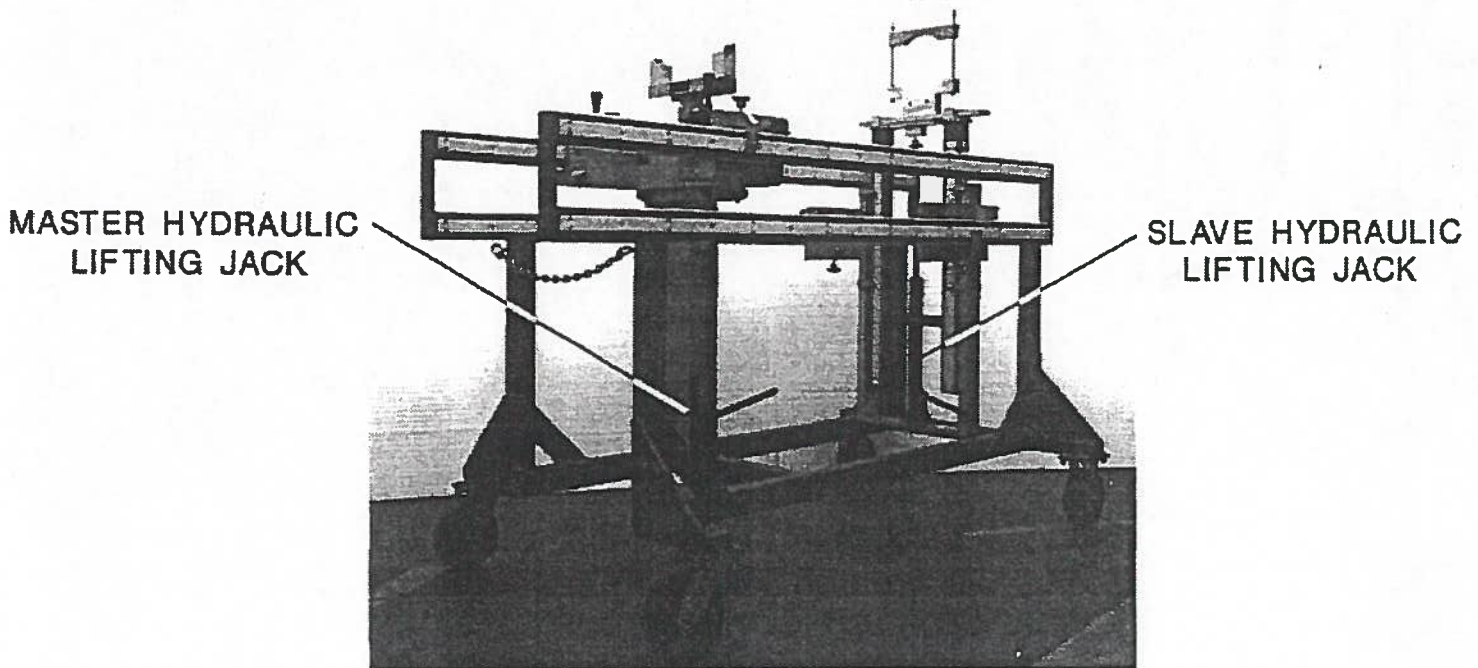
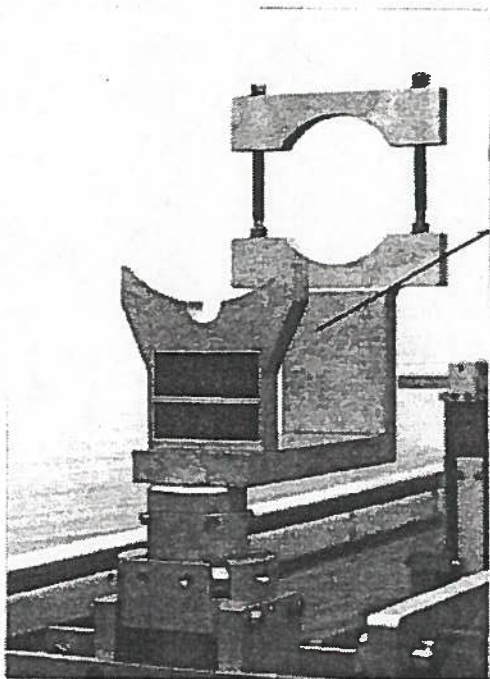


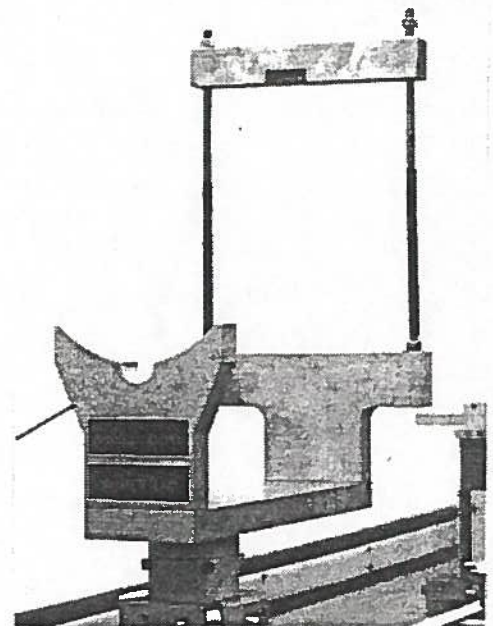
FIG. 2

The master jack assembly (D-36072) is designed so different handling fixtures can be easily mounted to handle several models of manipulators. The master handling fixtures for the Model G, G-HD, G-HDE, L, and L-HD manipulator are similar and are shown in Figs. 3 and 4. The positioning and clamping of the handling fixture on the manipulator is shown in Fig. 5.



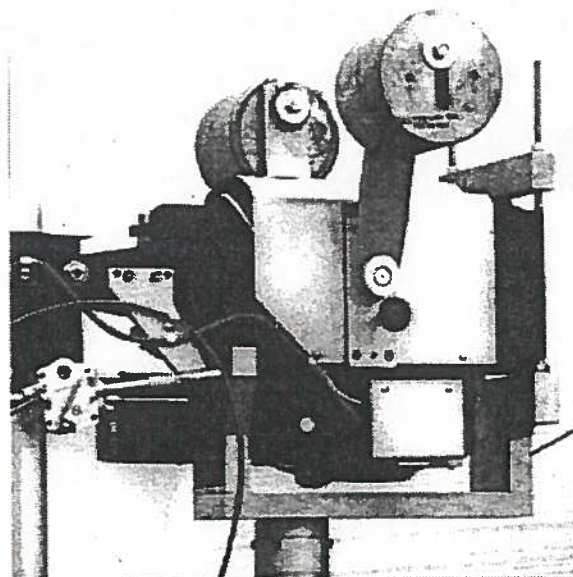
G, G-HD AND  
G-HDE HANDLING  
FIXTURE

FIG. 3



L AND L-HD  
HANDLING  
FIXTURE

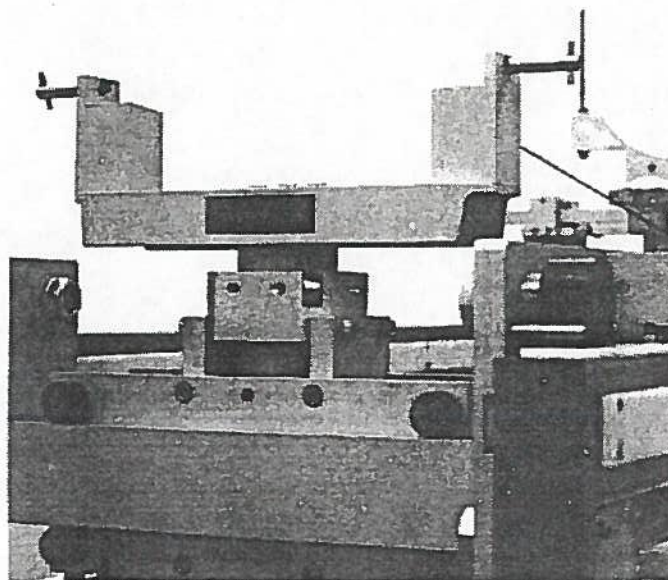
FIG. 4



HANDLING FIXTURE

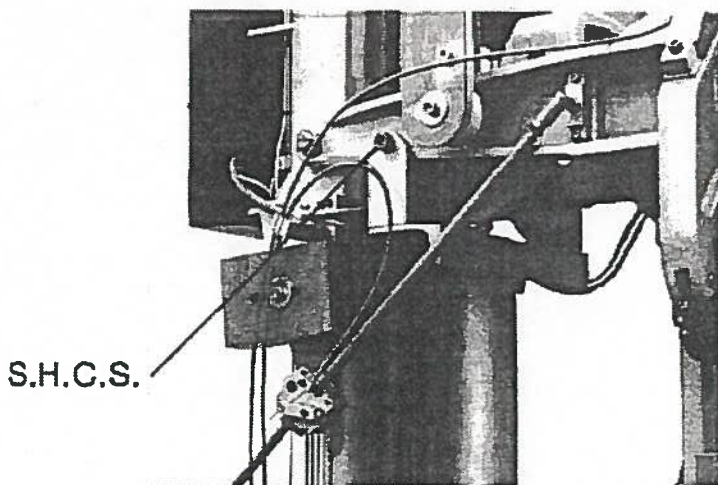
FIG. 5

The master handling fixture for the Model 8, E, E-HD, and F manipulator is shown in Fig. 6. The positioning of the handling fixture on the manipulator is shown in Fig. 7 and is held in place with two socket head cap screws.



8, E, E-HD AND F  
HANDLING FIXTURE

FIG. 6

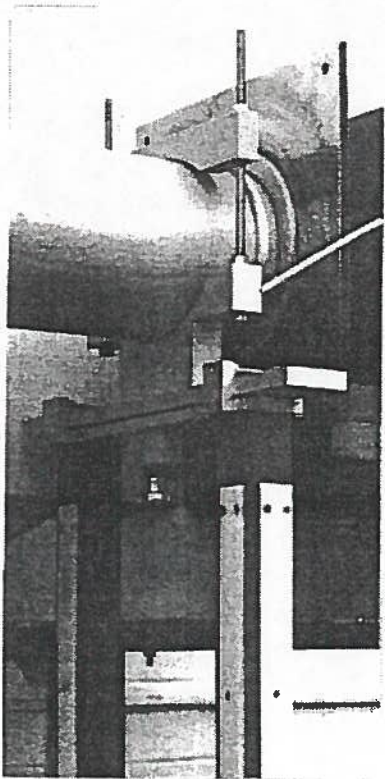


S.H.C.S.

FIG. 7

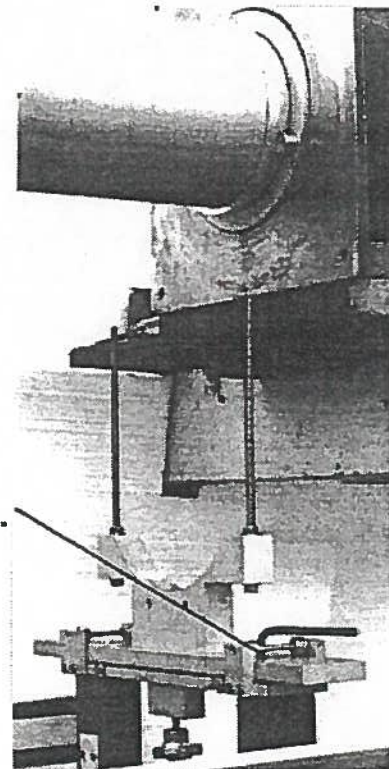
The slave jack assembly (D-38130) has a common handling fixture which can be used for all model types of manipulators (Fig. 8). When using the system for removal or installation of Model 8, E, E-HD, or F type manipulators, it is some times necessary to remove the slave handling fixture to allow the lower lateral counterweights to pass through the slave jack assembly. This can be easily done by removing two socket head cap screws (Fig. 9).

To raise the jacks, turn the relief valve located on the jack base (Fig. 10) firmly to the right and insert the jack handle in the socket and raise by pumping. To lower the jack, turn the relief valve slowly to the left. To stop, turn the relief valve firmly to the right. The transportation car is equipped with large diameter wheels and can be used to transport the manipulator to and from the cell area.



SLAVE HANDLING  
FIXTURE

FIG. 8



S.H.C.S.

FIG. 9

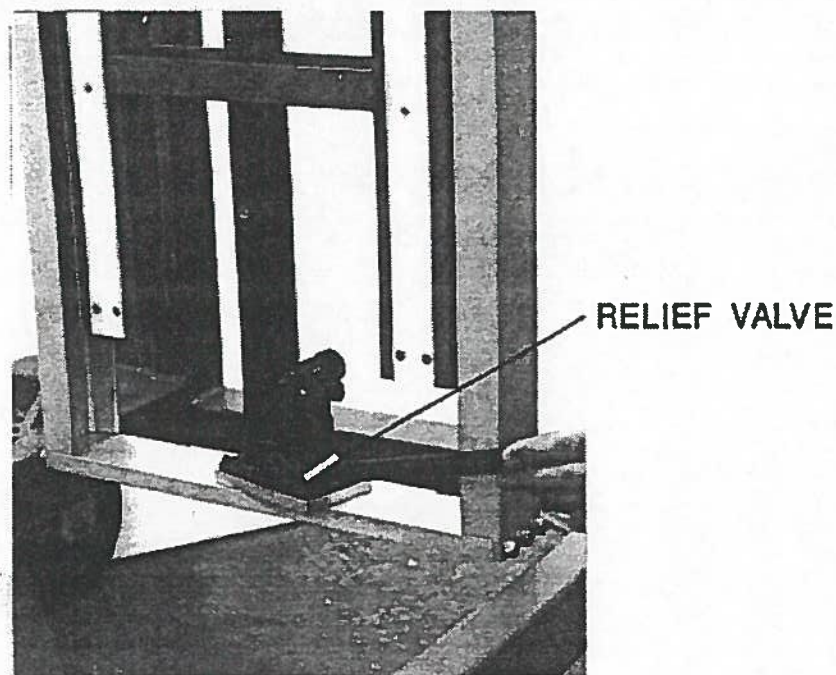


FIG. 10

#### B. D-24220 Lift Table Assembly

The second part of the system consists of a 2000 pound (900 kg) capacity hand-operated hydraulic lift table which will provide 49 inches (1240 mm) of vertical lift (Fig. 11). The lift table is supported on wheels, has a hand-operated hydraulic jack, and a foot operated floor lock. To raise the lift table, turn the relief valve located on the jack base (Fig. 12) firmly to the right and insert the jack handle in the socket and raise by pumping. To lower the lift table, turn the relief valve slowly to the left. To stop, turn the relief valve firmly to the right.

**CAUTION:** The lift table has hose break valves mounted on each hydraulic cylinder for safety. In the event of a hydraulic hose break when the lift table is elevated, the valves will lock the lift table in position and prevent it from lowering. If the lift table is lowered too fast by opening the relief valve on the hydraulic jack, the hose break valves may activate and hold the lift table up. If this condition should occur, close the relief valve and pump the lift table up a few inches. Then slowly open the relief valve on the pump and lower the lift table more slowly.



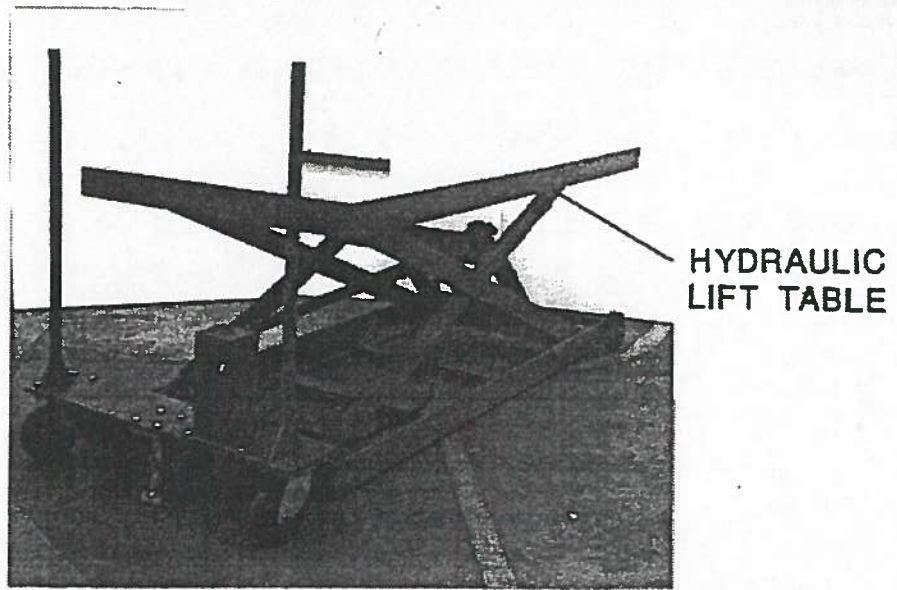


FIG. 11

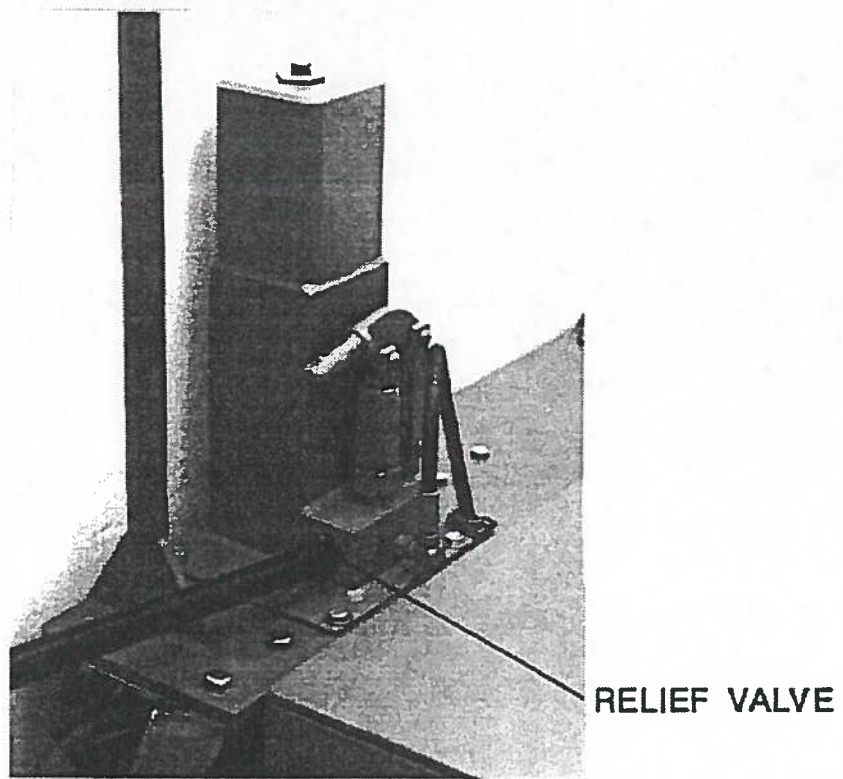


FIG. 12

## II. TYPICAL MANIPULATOR INSTALLATION PROCEDURE

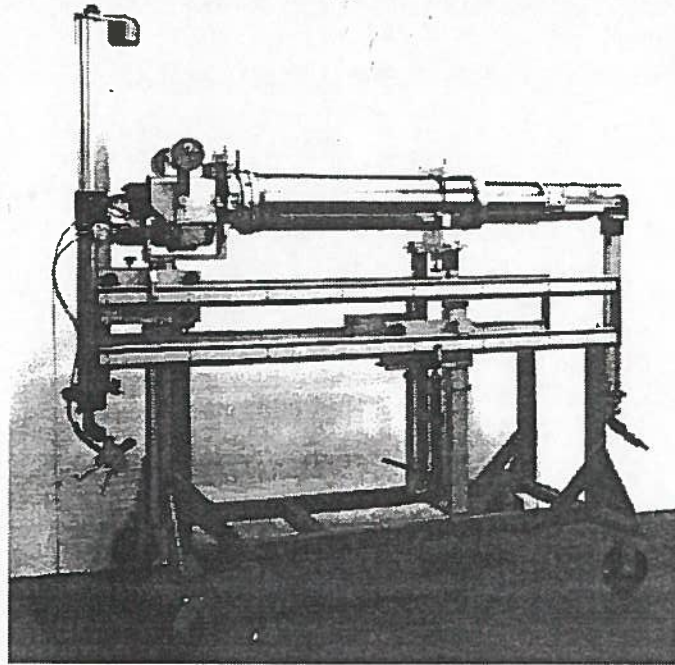
The following procedure is intended to illustrate the basic use of the manipulator installation cart to install a telemanipulator through the wall. For this procedure the Model L-HD manipulator will be used in the illustrations. Detailed installation instructions for each manipulator type are contained in the Installation/Operation/Maintenance Manual for the type of manipulator you are installing. Review the manual before installing the manipulator.

1. Mount the master handling fixture for the type of manipulator you are handling on the master jack assembly. With a hoist, position the manipulator on the transportation cart as shown in Fig. 13 or 14 and secure the manipulators to the jack handling fixtures. Check that the master handle will clear the frame of the transport cart when the arm is moved. If necessary raise the manipulator with the master and slave jacks.

**Note:** The master jack should be positioned as far as possible toward the master end of the transport cart. The slave jack should be positioned so it is 3 to 4 inches (75 to 100 mm) away from the slave rollers on the Model L-HD or from the slave roller trucks on other manipulator types. This is necessary so the rollers can enter the wall tube before the slave jack is removed.

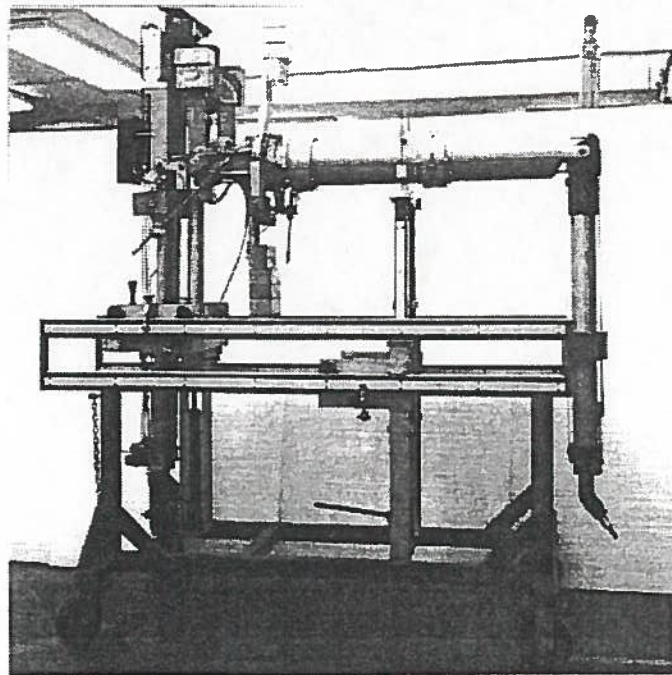
2. The longitudinal locks on each jack should be locked to hold the manipulator into position. The lateral locks should be locked at the center of lateral travel.

**Note:** Each jack assembly has two locks for the longitudinal motion and one lock for the lateral motion.



MODEL L-HD  
SHOWN

FIG. 13



MODEL E  
SHOWN

FIG. 14

3. Transport the manipulator to the hot cell area and position the manipulator and transport cart in line with the centerline of the wall tube. Roll the lift table assembly under the transport cart and raise the lift table until the wheels on the transport cart come off the floor.
4. Extend the manipulator in Y motion so the slave arm is horizontal (Fig. 15). With the master handle, adjust the tong so it is pointing straight ahead. Make sure the master boom tube is fully collapsed in Z motion and lock the motion lock to hold the tong and boom tube in position. Check the manipulator tube for levelness and adjust the slave and master jacks as required to level the thru tube.

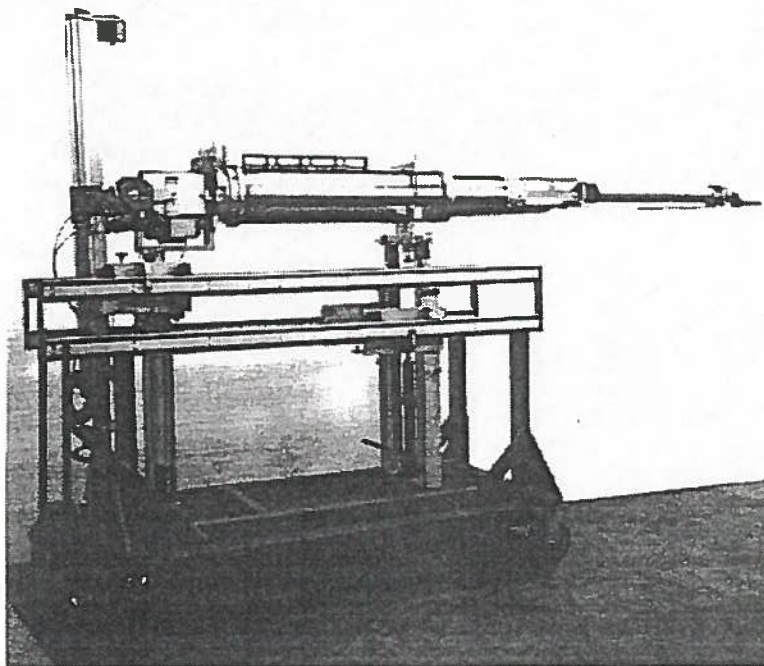


FIG. 15

5. With the lift table, raise the manipulator until the thru tube centerline is about 2 inches (50 mm) or less below the centerline of the wall tube. With the master and slave jacks mounted on the transport cart, raise the manipulator the remaining distance until the manipulator centerline is in line with the wall tube centerline.
6. Adjust the lateral position of both master and slave carriages so the manipulator is aligned with the wall tube centerline. Lock the lateral carriages.
7. Push the lift table cart toward the wall as far as possible. As the slave arm of the manipulator enters the wall tube, make height and lateral adjustment as required to position the arm in the center of the wall tube. When the lift table is moved as close to the wall as possible, set the floor lock on the lift table.
8. Release the longitudinal locks on both master and slave jacks and roll the manipulator and jack assemblies toward the wall as far as possible (Fig. 16). The slave jack should reach the end of its longitudinal travel. Lock the longitudinal locks on both master and slave jack assemblies.

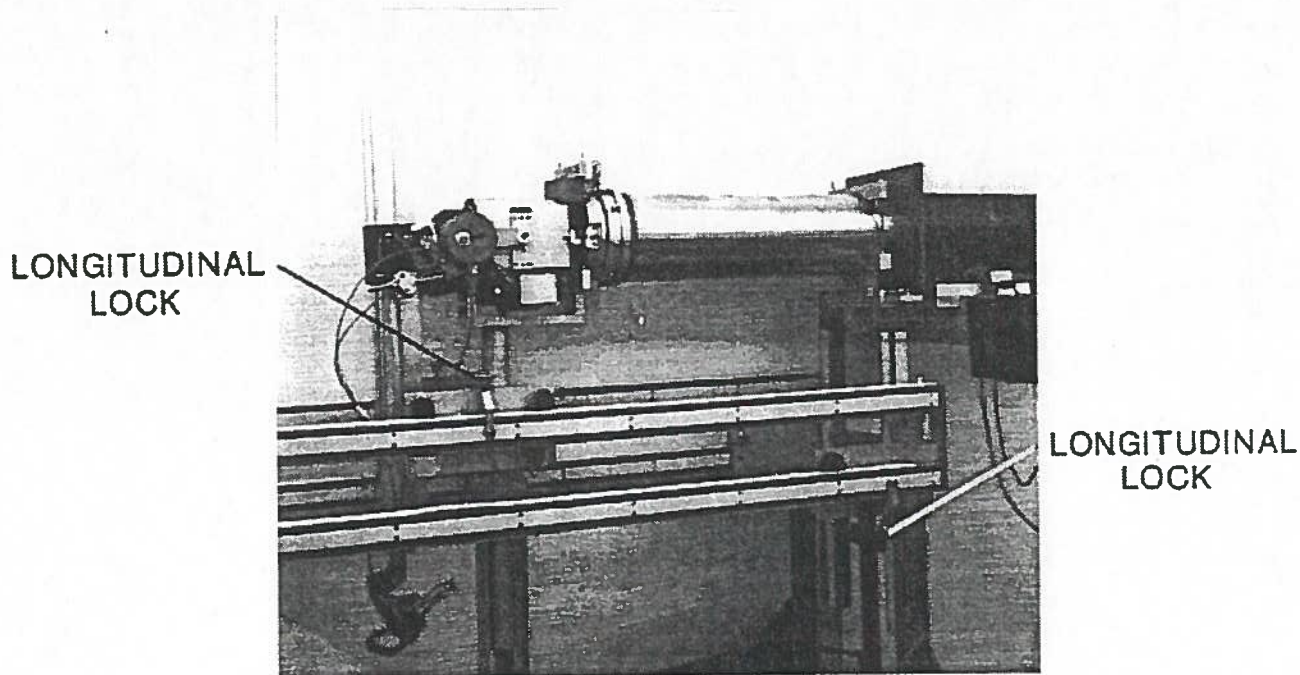


FIG. 16

9. Check that the rollers on the Model L-HD seal tube have entered the wall tube (Fig. 17) or the slave roller truck for other model types has entered the wall tube (Fig. 18).

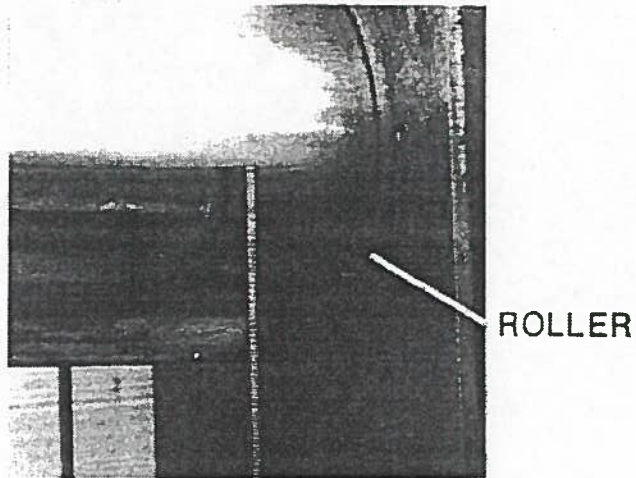


FIG. 17

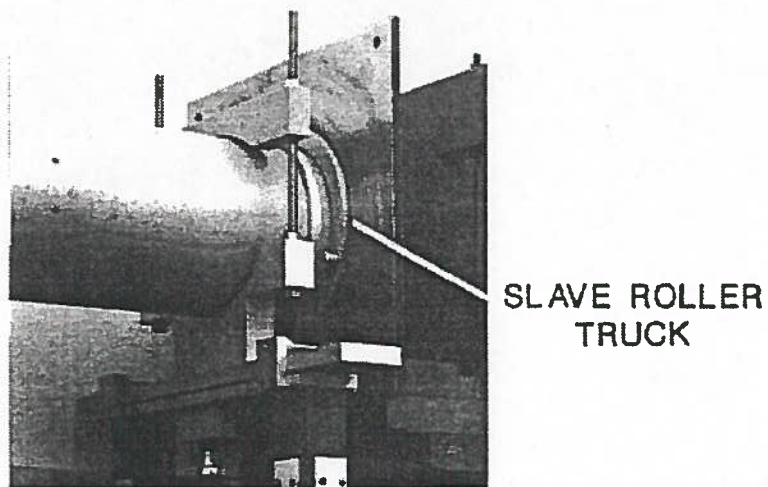


FIG. 18

10. Remove the clamp bar holding the slave jack to the manipulator and lower the slave jack completely.

**Note:** If you are installing a Model 8, E, E-HD, or F manipulator, it is sometimes necessary to remove the slave handling fixture to allow the lower lateral counterweights to pass through the slave jack assembly. This can be easily done by removing two socket head cap screws (Fig. 19).

11. Release the longitudinal locks on the master jack and roll the manipulator and jack assembly toward the wall until the Model L-HD seal tube has completely entered the wall tube (Fig. 20) or, for other model types the master roller truck has completely entered the wall tube (Fig. 21). Lock the longitudinal locks on the master jack.

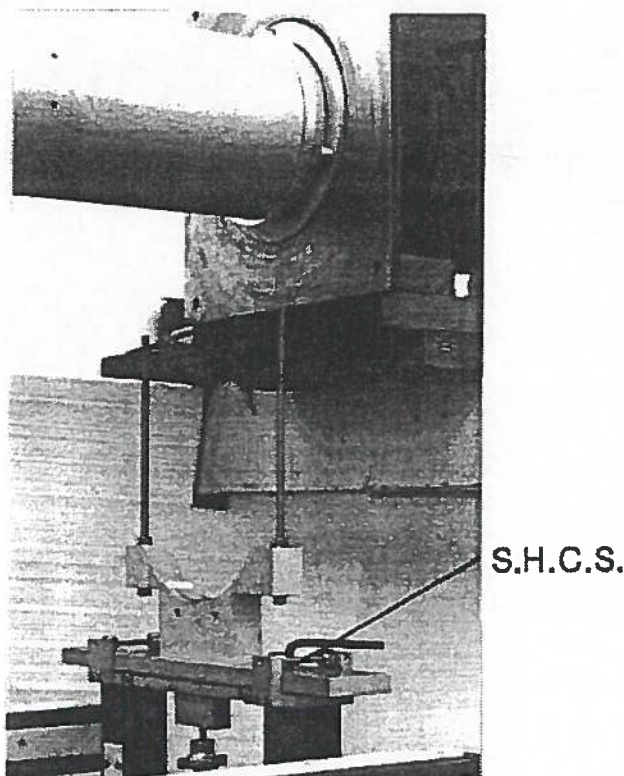


FIG. 19

LONGITUDINAL  
LOCK

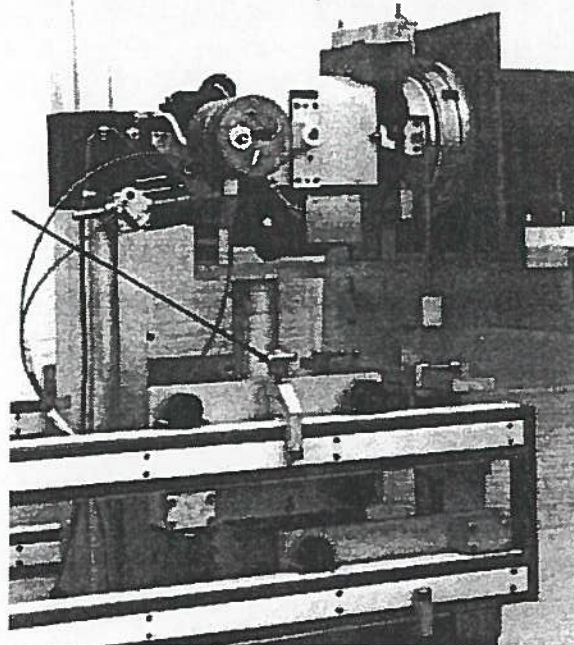


FIG. 20

LONGITUDINAL  
LOCK

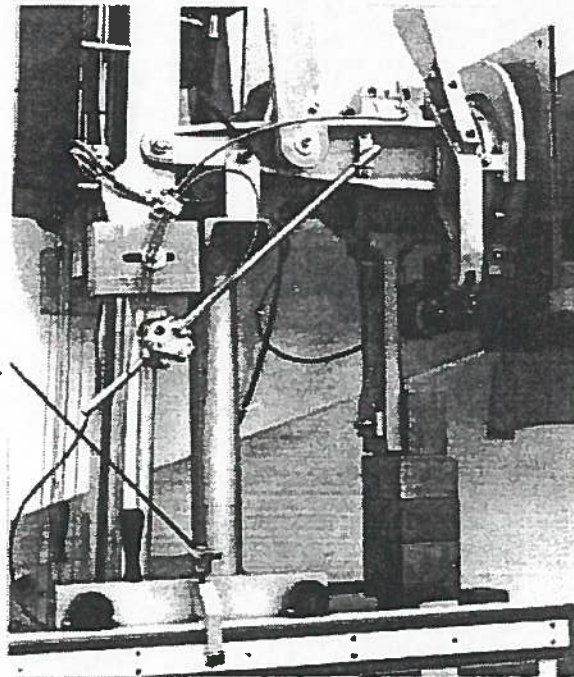


FIG. 21



12. Secure the manipulator to the wall tube following the installation instructions in the Installation/Operation/Maintenance manual and the assembly drawings provided for the model type you are installing.
13. Electrically index the slave arm in Y motion to a vertical position.
14. Disconnect the manipulator from the master jack handling fixture and lower the master jack completely. Lower the lift table completely and remove the lift table and transport cart.
15. This completes the manipulation installation procedure.

### III. TYPICAL MANIPULATOR REMOVAL PROCEDURE

The following procedure is intended to illustrate the basic use of the manipulator installation cart to remove a telemanipulator from the wall. For this procedure the Model L-HD manipulator will be used in the illustrations. Detailed removal instructions for each manipulator type are contained in the Installation/Operation/Maintenance Manual for the type of manipulator you are removing. Review the manual before removing the manipulator.

1. Mount the master handling fixture for the type of manipulator you are handling on the master jack of the transport cart.
2. Position the transport cart under the master arm of the manipulator in line with the centerline of the thru tube. Move both master and slave jacks as far as possible toward the cell wall.

**Note:** If you are removing a Model 8, E, E-HD, or F manipulator, it is sometimes necessary to remove the slave handling fixture to allow the lower lateral counterweights to pass through the slave jack assembly. This can be easily done by removing two socket head cap screws (Fig. 22).

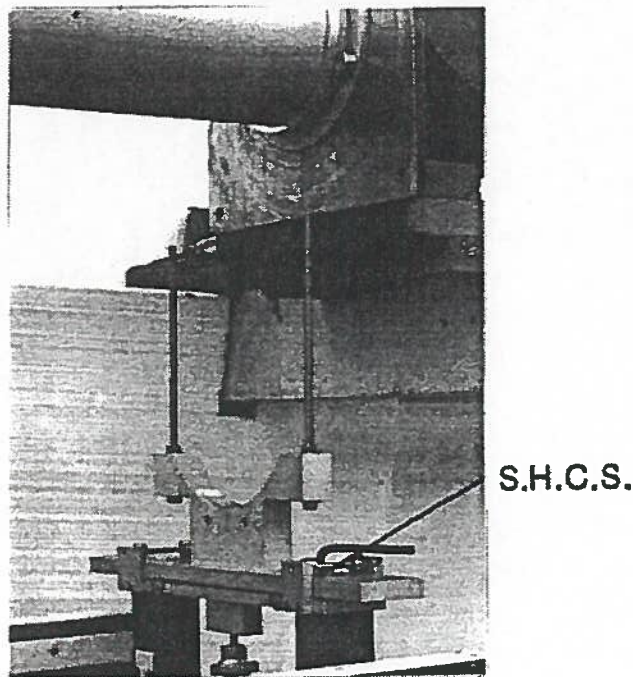
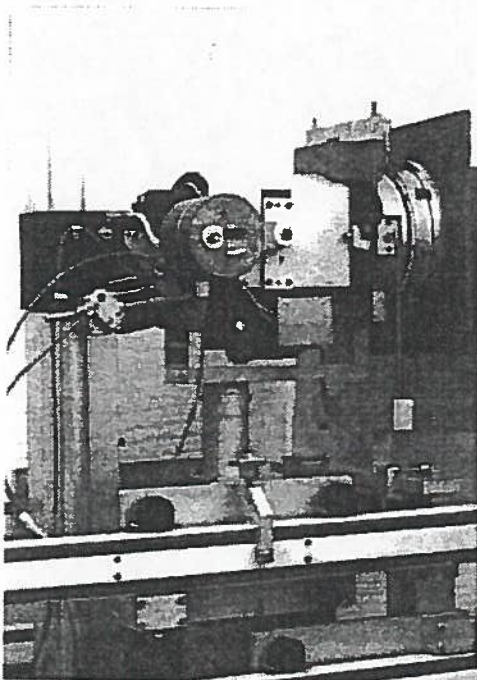
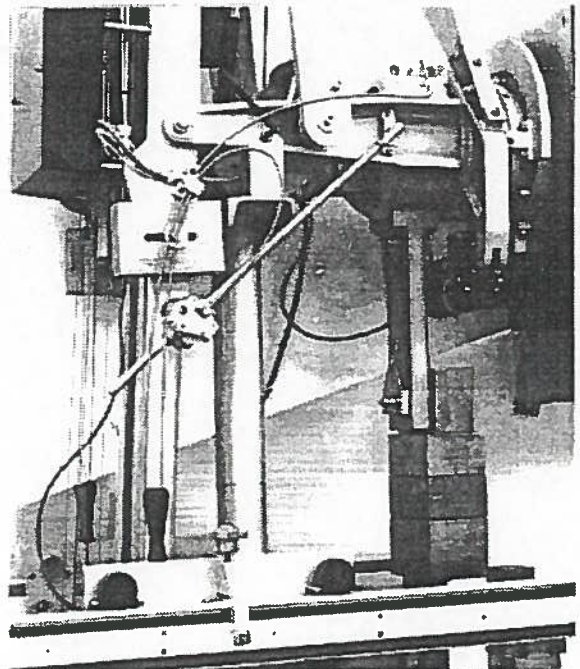


FIG. 22

3. Position the lift table assembly under the transport cart and elevate the transport cart with the lift table.
4. Extend the manipulator in Y motion so the slave arm is horizontal. With the master handle, adjust the tong so it is pointing straight ahead. Make sure the master boom tube is fully collapsed in Z motion and lock the motion lock to hold the tong and boom tube in position.
5. Elevate the master jack assembly until the master handling fixture cradles the master arm and secure the manipulator to the master handling fixture. Fig. 23 is typical of the Model G, G-HD, G-HDE, L, and L-HD type manipulators and Fig. 24 is typical of the Model 8, E, E-HD, and F type manipulators.
6. Set the floor lock on the lift cart and lock the longitudinal lock on the master jack assembly.



MODEL L, L-HD, G-HD,  
G-HDE AND G TYPE  
FIG. 23



MODEL 8, E, E-HD AND F TYPE  
FIG. 24

7. Disconnect the manipulator from the wall tube following the instructions the Installation/Operation/Maintenance manual for the manipulator type that is being removed.
8. Make sure the master jack is supporting the master arm by raising or lowering the master jack slightly. Release the longitudinal locks on the master jack and slowly pull the manipulator out of the wall tube by rolling the jack along the transport cart rails until the slave rollers on the Model L-HD (Fig. 25) or the slave roller trucks (Fig. 26) for other model types are just in the wall tube and supporting the manipulator. Lock the longitudinal locks on the master jack.

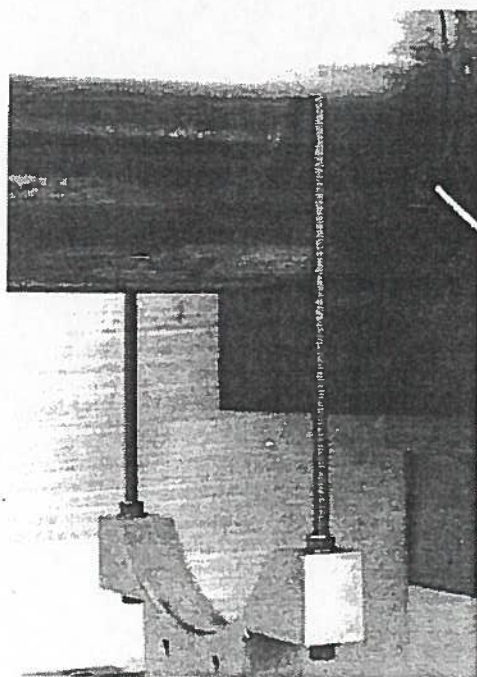


FIG. 25

SLAVE ROLLER

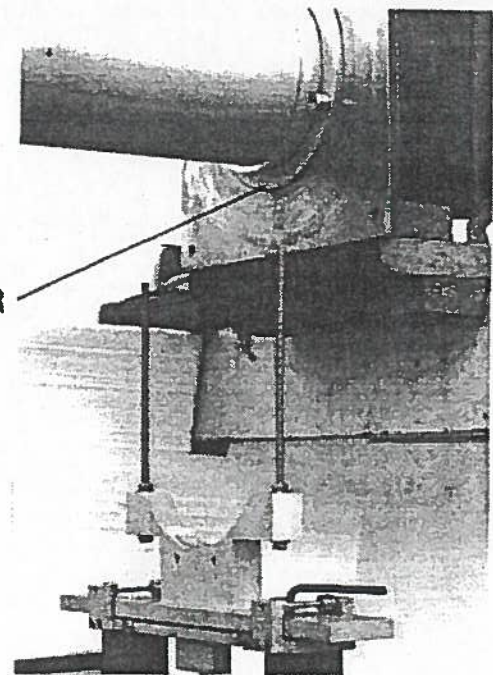
SLAVE ROLLER  
TRUCK

FIG. 26

9. Elevate the slave jack and secure the manipulator to the slave handling fixture (Fig. 27).
10. Release the longitudinal locks on both the master and slave jacks and slowly roll the manipulator back along the transport cart. Normally the manipulator should be move out until the master jack reaches its limit of travel. Lock the longitudinal jacks on both the master and slave jacks.
11. Release the floor lock on the lift table and pull the lift table away from the wall until the manipulator tong is out of the wall tube.
12. Lower the lift table until the transport cart is on the floor and pull the lift table out from under the transport cart.
13. Retract the slave arm with electrical Y motion until the slave arm is vertical. Lower the master and slave jacks until the manipulator is as low as possible.
14. This completes the manipulator removal procedure.

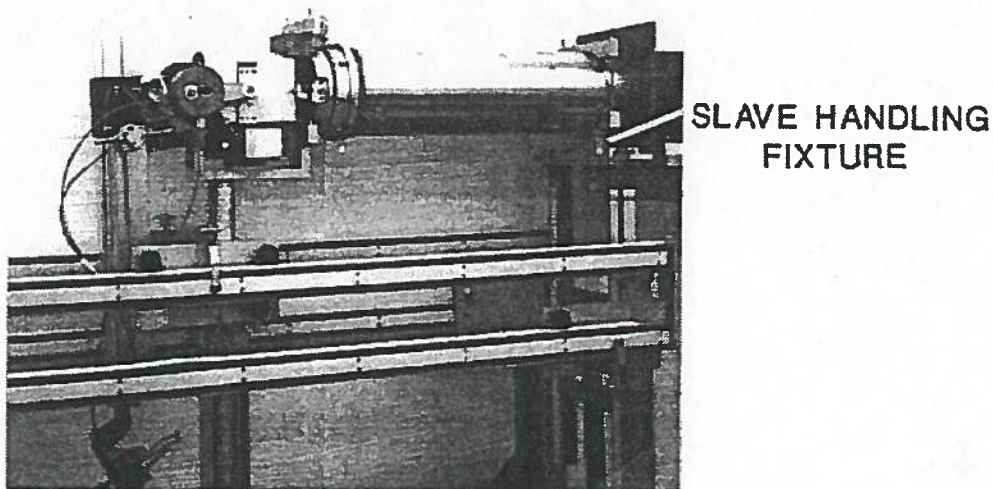


FIG. 27

#### IV. Model L or L-HD MASTER ARM REMOVAL FROM THE SEAL TUBE

This procedure is intended for removal of the Model L or L-HD master arm from a seal tube installed in the cell wall when maintenance of the master arm only is required. Detailed removal instructions are contained in the Installation/Operation/Maintenance Manual for the Model L and L-HD.

1. Mount the master handling fixture for the Model L, L-HD manipulator on the master jack of the transport cart.
2. Place the Y motion and wrist joint timing pins in the master arm. Engage the ratchet on the master handle and close the tong about half way. Collapse the master boom tube, orientate the azimuth so the tong is pointing straight ahead, and lock the manipulator Z motion lock. Remove the upper lateral counterweight on the master transfer assembly.
3. Position the transport cart under the master arm of the manipulator in line with the centerline of the thru tube. Move both master and slave jacks as far as possible toward the cell wall.
4. Position the lift table assembly under the transport cart and elevate the transport cart with the lift table.
5. Elevate the master jack assembly until the master handling fixture cradles the master arm and secure the manipulator to the master handling fixture (Fig. 28). With a wrench, disengage the slave arm from the seal tube by rotating the disengagement shaft. The slave arm locks automatically when disengaged from the seal tube.

**CAUTION:** The slave arm must always be disengaged from the seal tube before the master arm is removed or the slave arm will crash down in Z motion.

6. Set the floor lock on the lift cart and lock the longitudinal lock on the master jack assembly.
7. Back out the three screws which engage the master arm to the seal tube (Fig. 28).

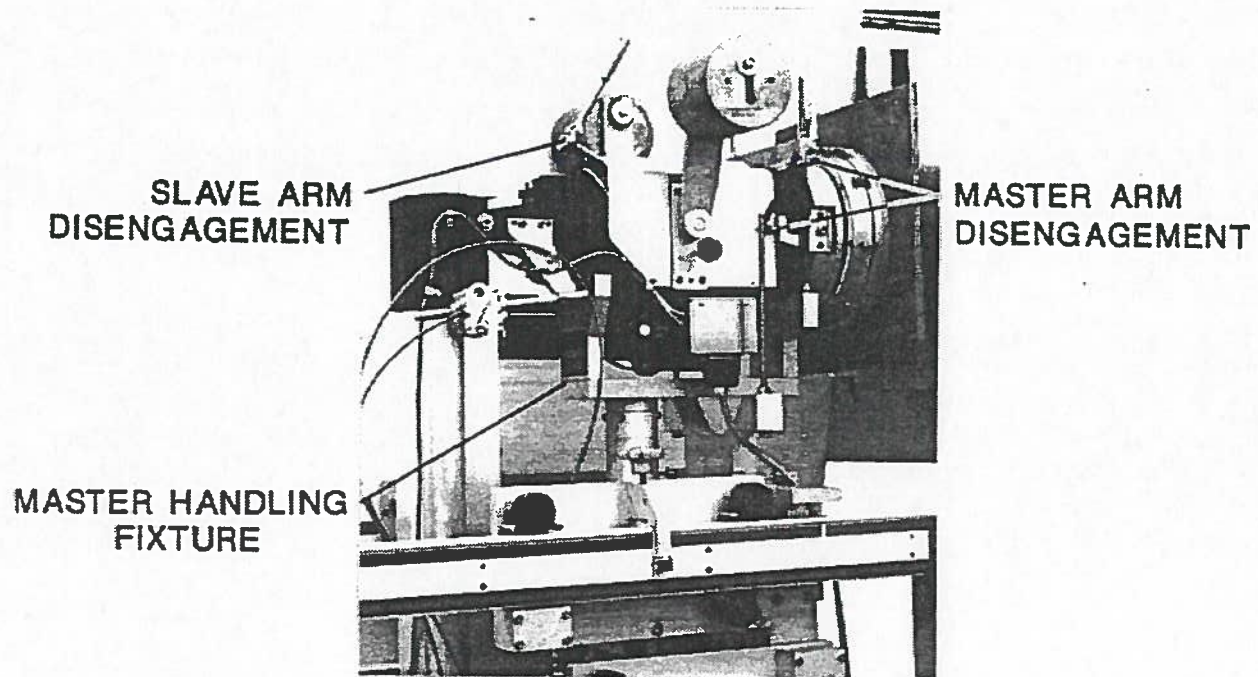


FIG. 28

8. Release the longitudinal lock on the master jack and move the manipulator away from the seal tube until the pins in the master arm are aligned with the vertical slots in the mounting brackets on the seal tube.
9. Raise the master arm with the master jack until it is clear of the mounting brackets and roll it back away from the seal tube (Fig. 29). Lock the longitudinal locks on the master jack.
10. Lower the lift table until the transport cart is on the floor and pull the lift table out from under the transport cart.
11. This completes the Model L, L-HD master arm removal procedure.

LONGITUDINAL  
LOCK

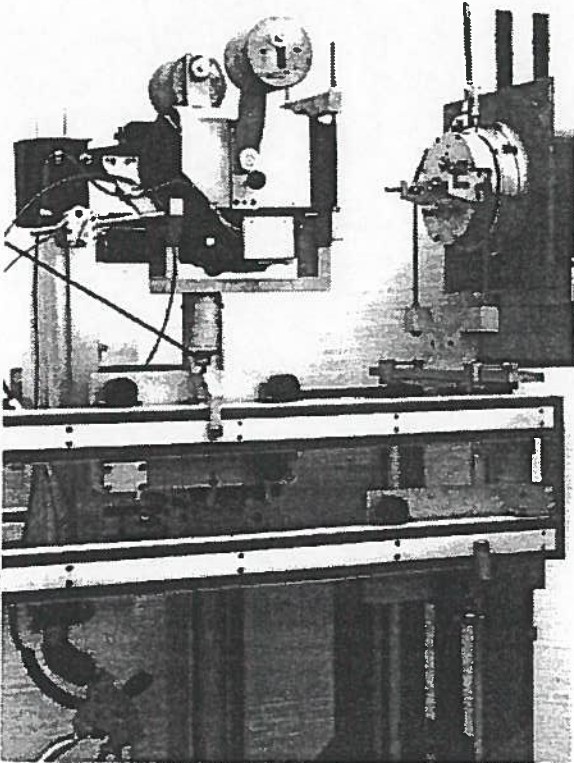


FIG. 29

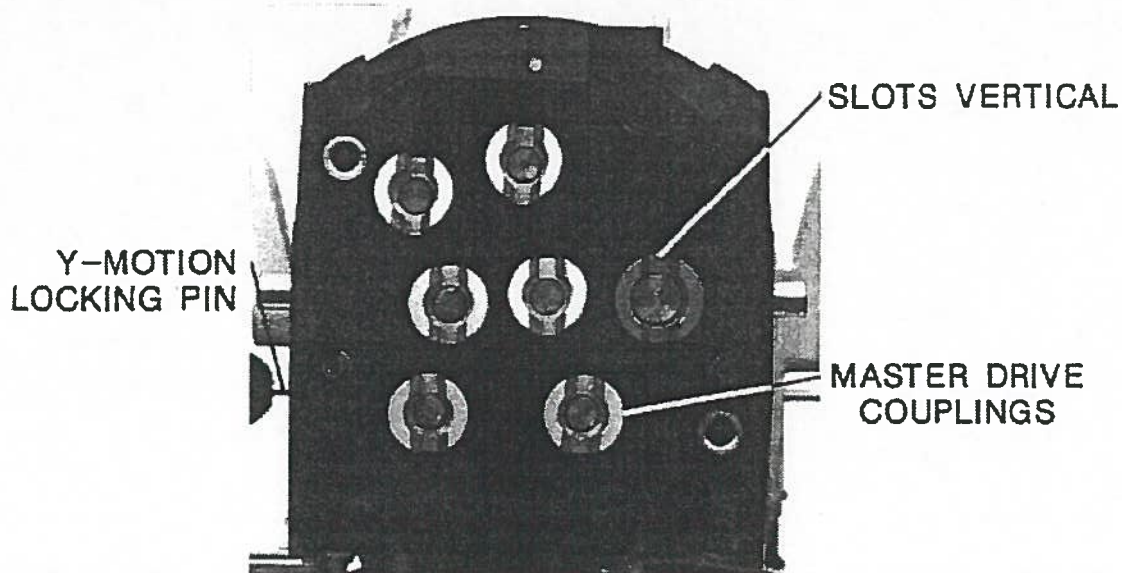


**V. Model L or L-HD MASTER ARM INSTALLATION ON THE SEAL TUBE**

The following procedure is intended to illustrate the basic use of the installation cart to install a Model L or L-HD master arm on a seal tube installed in the cell wall. Detailed installation instructions are contained in the Installation/Operation/Maintenance manual for the Model L or L-HD. Review the manual before installing the master arm.

1. Remove the upper lateral counterweight from the master transfer assembly and place the master arm in the following reference positions prior to installation on the seal tube.
  - a. The Y locking pin should be in position.
  - b. The wrist joint timing pin should be in position.
  - c. The master boom tube should be fully collapsed.
  - d. The azimuth should be in its neutral position, so the handle is pointing straight ahead.
  - e. The handle should be in a full-open position.

This positions the master couplings so the slots are in a vertical position (Fig. 30).

**FIG. 30**

3. Check the seal tube to see that the drive pins in the transfer shafts are vertical and the tong and Y shafts are in an up position (Fig. 31).
4. Position the master arm on the Model L, L-HD handling fixture on the master jack of the transport cart and secure the master arm to the handling fixture (Fig. 32). Lock the longitudinal and lateral locks on the master jack.

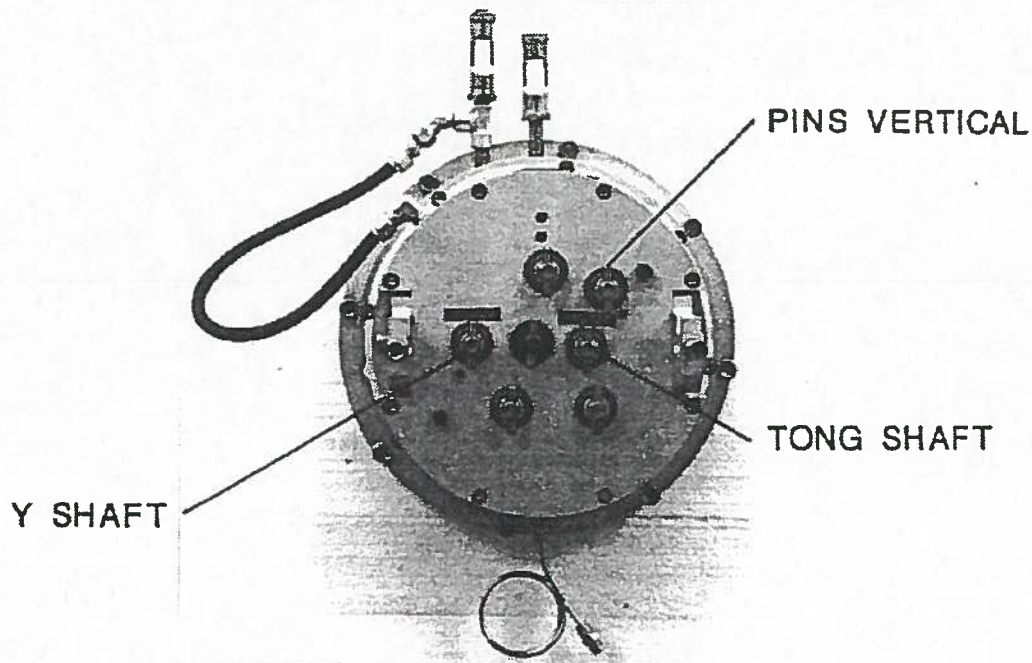


FIG. 31

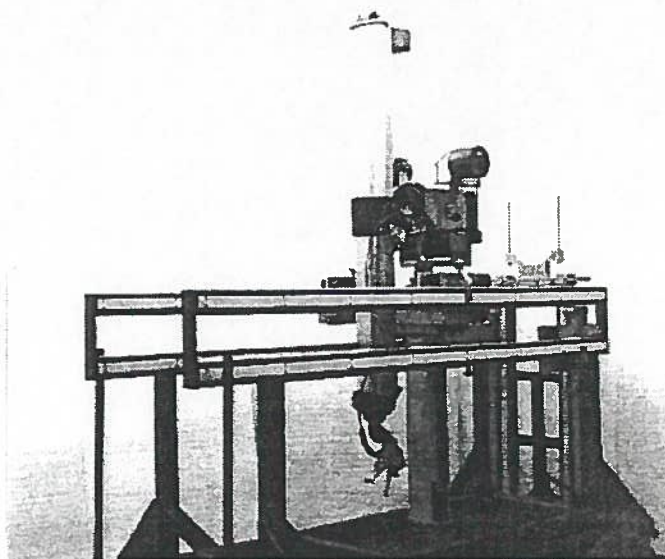


FIG. 32

5. Position the lift table and transport cart under the seal tube in line with the centerline of the seal tube and set the floor lock on the lift table.
6. Raise the lift table and master jack until the master arm is slightly above the centerline of the seal tube (Fig. 33).
7. Move the master jack along the rails on the transport cart to position the master arm assembly over the vertical slots in the master ear-brackets on the seal tube. Lower the assembly with the master jack and push it into engagement with the seal tube. Lock the master arm to the seal tube with the three locking bolts ( Fig. 34).
8. Use a wrench to engage the slave arm to the seal tube by rotating the engagement shaft on the master transfer (Fig. 34).
9. Remove the clamp bar holding the master arm to the handling fixture and lower the lift table. Replace the upper lateral counterweight removed in Step No. 1.
10. Remove the Y motion and wrist joint timing pins. Slowly squeeze the handle to engage the tong motion drive. Check all manipulator motions for freedom of operation.
11. This completes the master arm installation procedure.

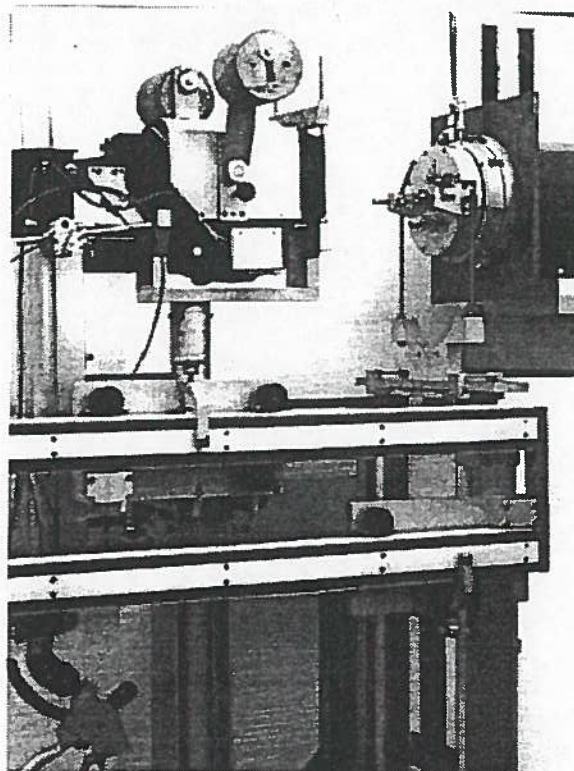
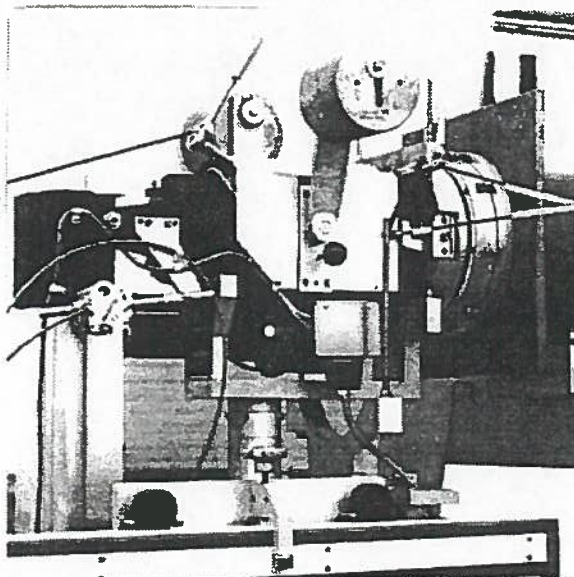


FIG. 33

SLAVE ARM  
ENGAGEMENT



MASTER ARM  
ENGAGEMENT

FIG. 34