REMOTE

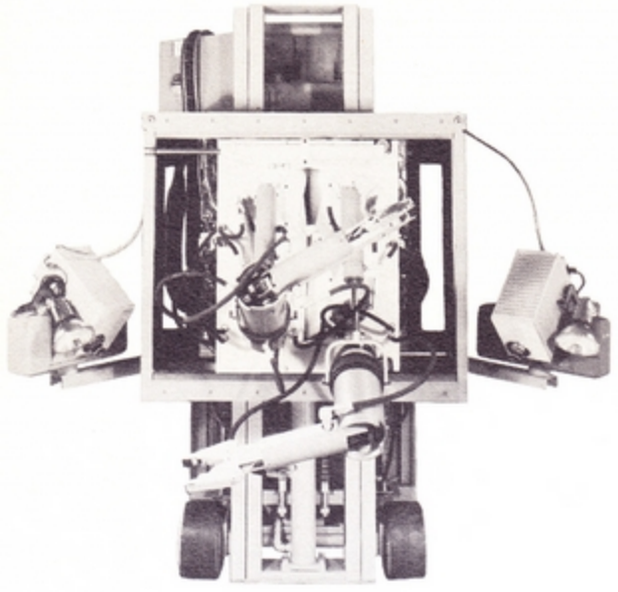
MOBILE HANDLER

MOBOT

HUGHES

HUGHES AIRCRAFT COMPANY
CULVER CITY, CALIFORNIA

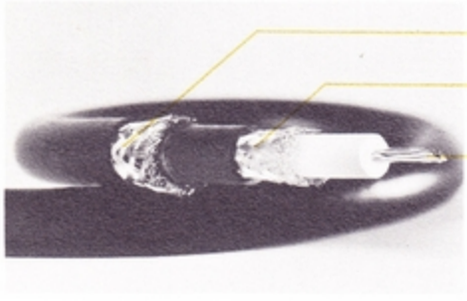
RADIOACTIVE MATERIALS HANDLER



MOBOT Mark I was produced for a government contractor for handling radioactive materials in areas where radiation is too high for humans. It handles weights in the 150 pound class and operates up to 200 feet from the operator. It is mounted on a standard forklift truck for convenience and economy.

Its two handling arms are each 3 feet long. Each arm has 360° shoulder rotation, 30° shoulder bend, and 120° elbow bend. The arms are mounted on positioning plates capable of 30 inches horizontal traverse, 5° forward and 10° backward tilt, and 10 feet elevation. The jaw grip pressure varies from 10 to 800 pounds. The two TV cameras have full pan and tilt control with continuous focus from 12 inches to infinity. All these functions are controlled by the operator. A third TV camera can be mounted on the wall to survey the entire operating area, with an associated monitor scope on top of the operator's console. Instrumentation on the mobile unit is a charging rate meter for the battery supply, a radiation count meter, and a pressure meter for the arm hydraulic supply – all read by the "right eye" of the machine.

The vehicle has a unitized drive and steering mechanism at the rear, providing four-speed control, either forward or reverse, with a maximum speed of 2 miles per hour. Steering automatically returns to straight ahead when the steering knob on the console is returned to zero; automatic braking is applied when the drive power is stopped. Range of steering control is ±90° from straight ahead, enabling the vehicle to turn in its own length. Operators typically required 30 to 60 minutes for familiarization with the Mark I controls. After 5 to 10 hours of operation, they could perform any movement and position electrical equipment on the benches. By 35 hours, they could position objects in three dimensions within 1/16 inch, consistently.



This is the triaxial cable that carries the command signals. Only ½ inch in diameter, it is carried on a power reel paid out and taken up by the mobile vehicle under operator control.

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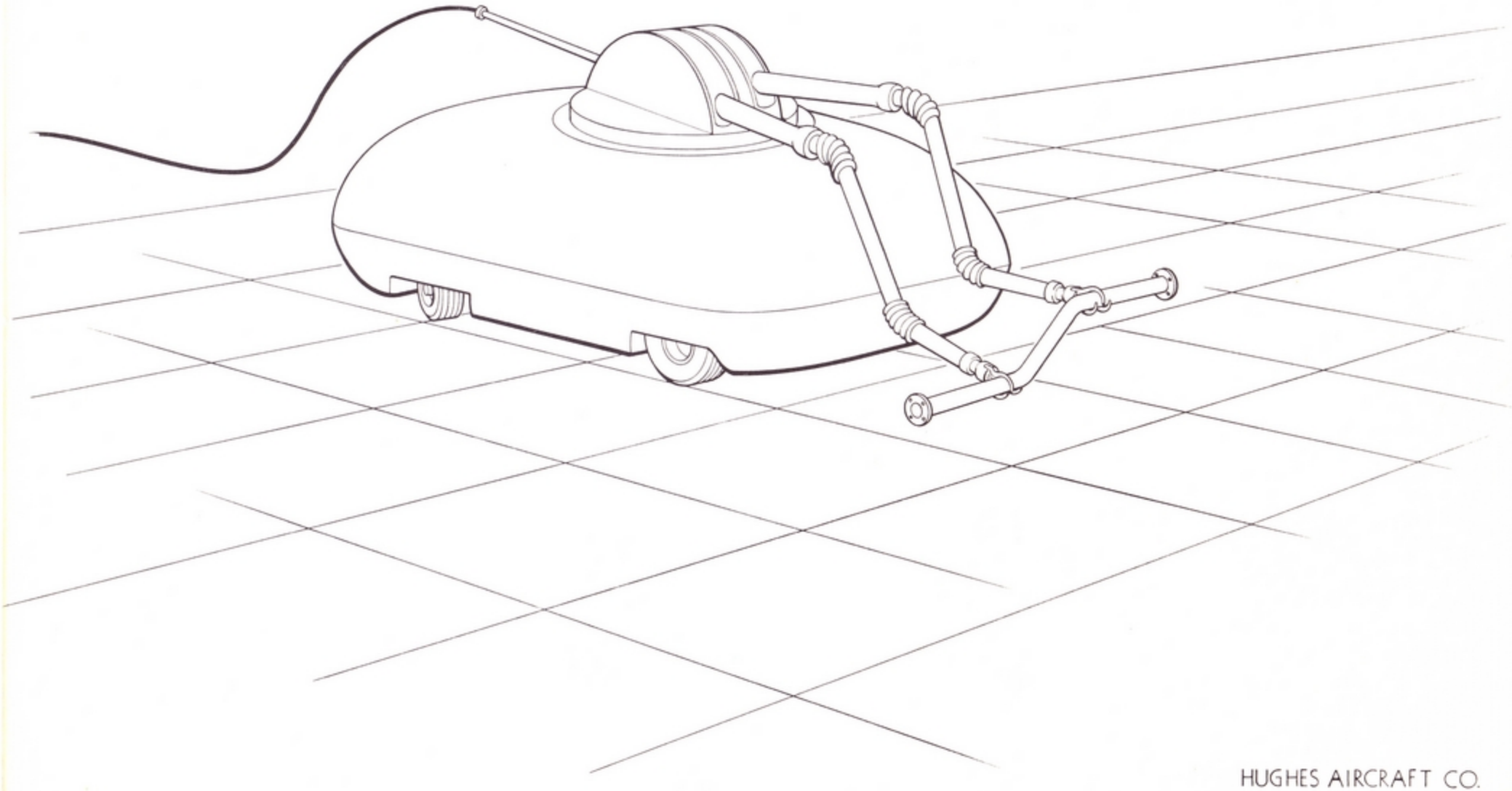
Mobile remote handling devices or vehicles can be designed and built to meet many different requirements. A film demonstrating MOBOT capabilities is available on request. For further information, contact Nuclear Electronics Laboratory, Post Office Box 90515, Airport Station, Los Angeles 45, California, telephone SPring 6-1515.



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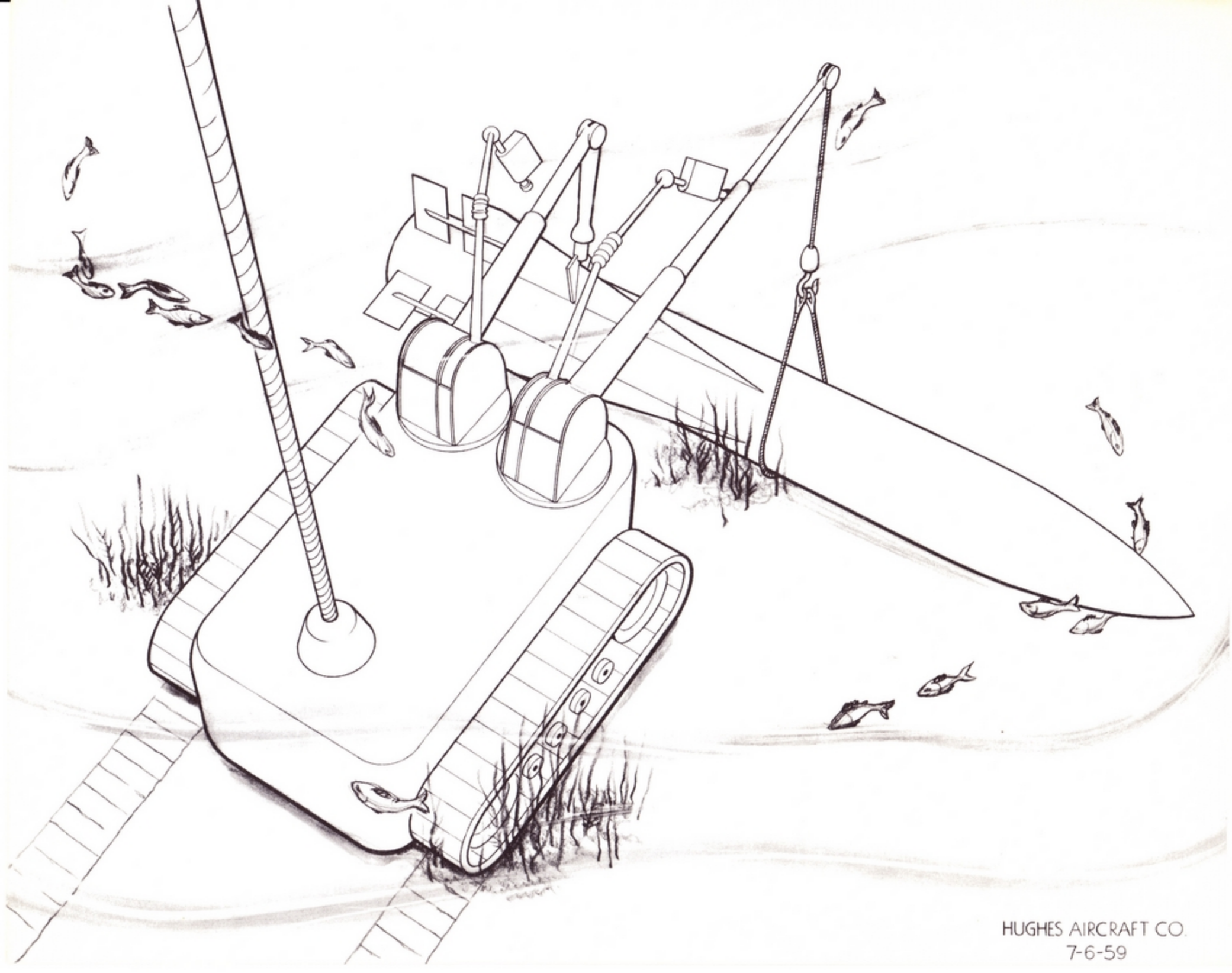

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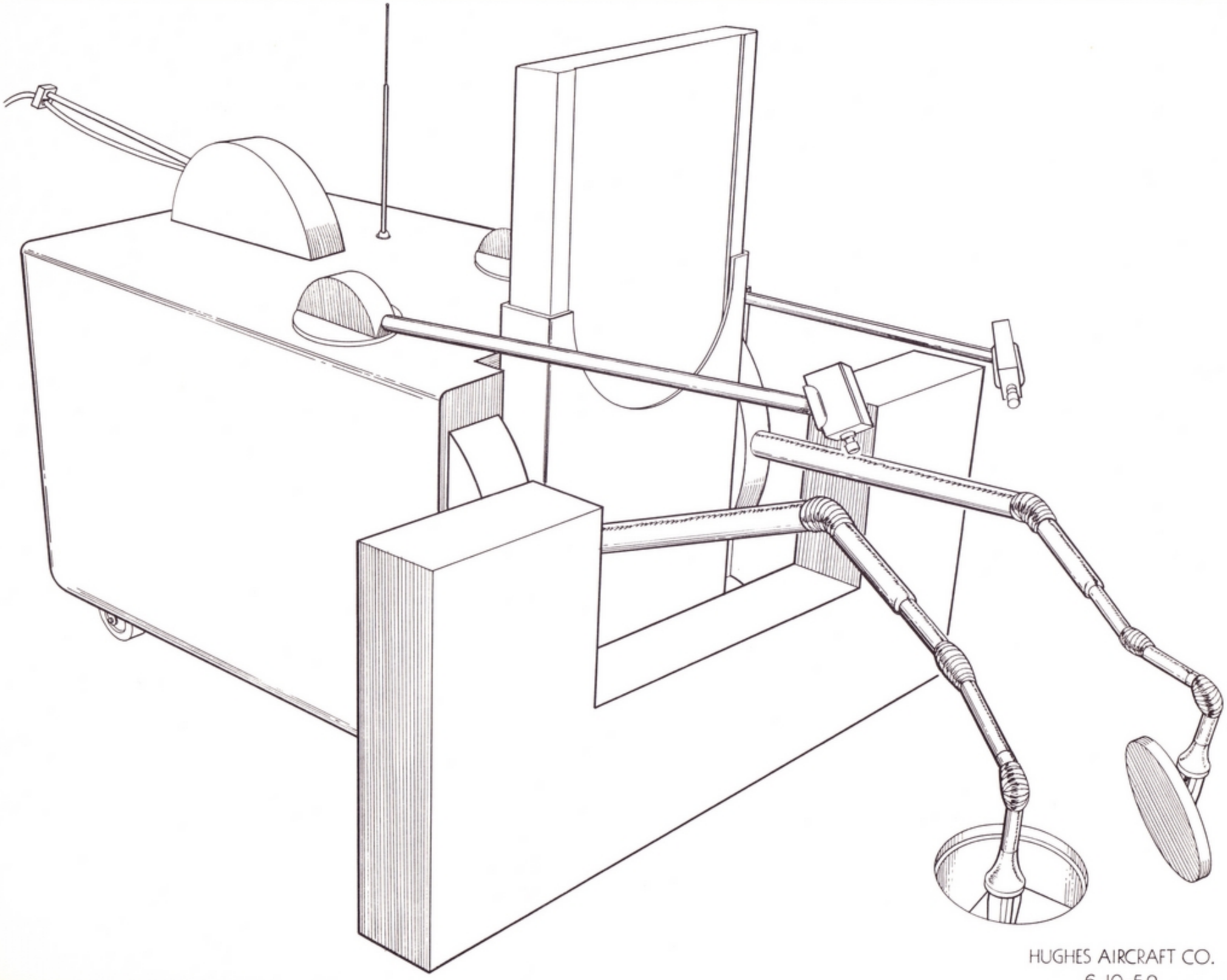

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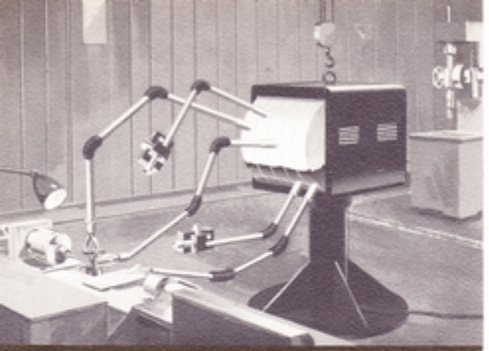


A HANDLER FOR HAZARDOUS ASSIGNMENTS

MOBOT*, the Hughes remote-controlled mobile manipulator, is designed to carry out complex handling operations in uninhabitable areas. Free-moving and completely remote-controlled, the MOBOT is a versatile and precise handling mechanism for operation in environments hazardous for human life because of radiation, heat, cold, or pressure, or for any handling assignment beyond a man's capacity.

MOBOT handlers can be designed to perform as many or as few functions as the handling problem requires. An operator at a console safely located outside the hazardous area steers the mobile vehicle and operates the manipulating arms and jaws. Using the operator's eyes and brain, the MOBOT vehicle can lift and carry equipment and perform routine chores. It can use power tools such as drills, wrenches, screwdrivers, saws, or welding and cutting torches.

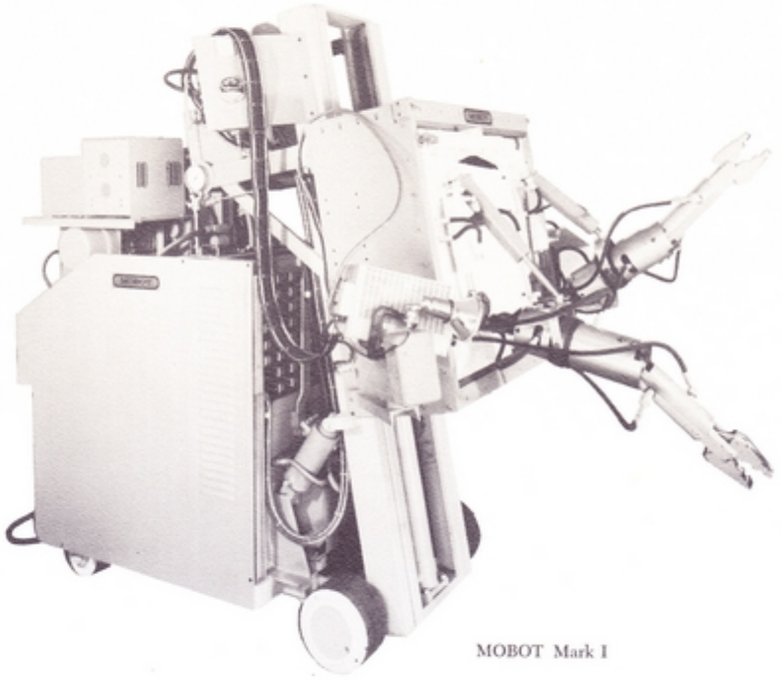
A "TYPICAL" MOBOT

MOBOT is a concept rather than a specific design, because it is felt that a generalized system is more effective, economical, and flexible than a specialized one, given a variety of handling situations. Thus, as illustrated, a wide range of designs are possible, depending on the weights to be handled, the distances involved, and the precision and speed required of the movements.

MOBOT MARK I

One model, designed for handling in a radiation area, is the Mark I, shown just before delivery to the customer. The handling arms can also be mounted on a boom, a tractor, a railroad car — anything mobile or stationary, as the situation requires. A MOBOT can be mounted on a turret, for example, for tasks such as lathe operation. More TV cameras can be used, some boom-mounted, to aid the operator. Any kind of wheels or tracks can be used. More or fewer handling arms can be provided.

*a trademark of Hughes Aircraft Company



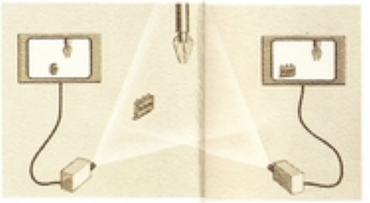
MOBOT Mark I

COMMAND SYSTEM — A simple but unique multiplexing system was developed for transmitting commands to the mobile vehicle. Consisting only of two black boxes and a cable, it is a digital control system which minimizes linearity requirements in the communication link and permits the use of synchronous commutating switches for multiplexing. A single three-conductor cable carries over 100 signals to the machine. This same cable carries 60-cycle a-c power to the vehicle and transmits two video channels and one audio channel from the vehicle to the control console. The latter functions are separated from the control channels by rf carrier frequency discrimination. This multiplexing system is also compatible with radio control.

CONTROL CONSOLE — The console is designed for simplicity and ease of operation, with minimum operator fatigue. Electrically operated pistol-grip controls are used for the handling arm movements. The steering control is a simple lever. Speed is controlled by a foot pedal. TV monitor screens show the handling arm movements in depth. A learning period of a few hours is all that is needed for the operator to be able to interpret audio-visual information and manipulate the controls.

HANDLING ARMS — The vehicle arms are capable of a variety of motions: shoulder rotation, transverse shoulder movement, and elbow movements. These movements are actuated by an electro-hydraulic system, chosen for smooth action and wide weight-lifting potentialities. The tightness of a hydraulic system is an additional advantage, particularly in handling extremely heavy objects.

REMOTE VISION — In order to operate the mechanism from his remote location, the operator must be able to see the objects being handled in three dimensions. The discovery was made early in MOBOT development that conventional closed-circuit television will give the operator more than adequate information concerning relative spatial position. Two television cameras are mounted so that their axes of vision intersect the operating area approximately at right angles. By comparing the views on his two monitor scopes, the operator can determine the relative positions of all the objects in view. This simple and inexpensive technique has been found far more effective than any of the elaborate display techniques in making remote operation possible.



THE NEXT MOBOTS — Current developments are aimed at increasing flexibility and precision of movement and lifting potential. A handling arm with two elbows and full wrist action is one new feature being developed. The wrist will have continuous rotation, with vertical and horizontal swing. Wheel sizes up to 60 inches, arm capacities from 25 to 250 pounds, a new steering system for crowded areas, and computers for complex or repetitive operations are other capabilities to be provided in future MOBOT models.