MONSANTO CHEMICAL COMPANY ~~SECRET~~ *Inter-Office Correspondence*

LOCATION : Mound Laboratory, Miamisburg, Ohio

DATE : December 15, 1960

SUBJECT : Report of Accident Investigation of the "F" Column Tritium Incident in the SW-8 Area

REFERENCE :

cc:

This Document Consists of 17 Pages
This is Copy 2 of 7A

MOUND LABORATORY-MONSANTO
Central File No. 60-12-205

~~SECRET~~
Date 12/22/60 Init. HEM

TO : J. F. Eichelberger
Research Director

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I. Summary

An accident, resulting from equipment failure, occurred in the "SW" Building at Mound Laboratory on November 23, 1960. This incident resulted in the loss of a quantity of tritium, minor contamination adjacent to the immediate accident location, and a small fire. Three persons working in the area at the time received minor radiation exposures. The estimated cost of gas loss, plus damage to the lower seal only of the thermal column involved in this incident, is approximately one thousand and sixty-five dollars.

II. Findings

On November 23, the "F" column in SW-8 was placed in operation after a six week's shutdown required to procure and install a new lower terminal block. The "F" column is a

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NAME Tim Flanagan
2ND REVIEW-DATE 5/18/99
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IN 10

thermal diffusion column used for separation of gaseous isotopes. It is a 24-foot column with an electrically heated center wire. The center wire and the associated power supply are not earth grounded. The outer jacket of the column is grounded to earth. Three glass-to-metal seals electrically insulate the center wire from the jacket. The outer jacket surrounds the gas tube and contains water for cooling. At the top of the column, in the center wire suspension element, is an 0.008 inch stainless steel bellows which isolates the mercury (cooling media) from the central portion of the column. The bellows also allows vertical movement of the center wire. See Sketch #1. The column is completely enclosed by a large, well-ventilated hood.

The accident investigation committee reviewed the Mound Secret Document #60-12-48 which chronicles the operational history of the "F" column from October 15, 1958, (the column was obtained from the Savannah River Plant) to the time of the incident. In the history, there are five instances recorded in which the column had been shut down because of leaks. The original upper assembly had been modified with a second bellows system to stop a tritium leak in the upper sealing unit. Also, there were two instances of electrical shorting in the column.

The following operating personnel were present at the time of the column failure:

Joyce J. Dauby, Research Chemist

Andrew Elmlinger, Jr., Senior Research Chemist

Marvin Fleischman, Research Chemist

Before placing the column in "hot" operation, it was leak checked. A pressure test showed a rate of rise of less than two microns per minute. This test compared very favorably with tests on the column in its original condition.

Just prior to the incident, the "F" column had been pressurized with tritium to 800 millimeters of mercury absolute

pressure. The motor generator was turned on to supply power to heat the center wire of the column. According to the "daily column log," by 1:28 P.M. the voltage across the center wire had been gradually increased in the normal manner to 19 volts and the electric current to 105 amperes. At the time and at this power level, there was no indication of trouble. Nineteen volts is about half the normal operating voltage; 105 amperes is about two-thirds of normal operating current. All electrical controls were in their proper operating position, and the column was operating properly as indicated by the signal lights.

At approximately 1:30 P.M., Marvin Fleischman observed an electrical arc near the base of the column. The arc was white and produced a hissing, crackling sound. Fleischman immediately alerted Andrew Elmlinger to the arc. Both men were standing near the column control panel as noted in Sketch #2. Elmlinger immediately turned off the motor generator which supplies power to the column, and later Fleischman opened the relay by-pass switch. Both controls are on the column control panel. When Elmlinger turned off the motor generator, he observed that the red indicator light went out simultaneously. This indicates that the motor generator had not been turned off by the automatic "no load" control relay as would have occurred, for example, if the center wire had broken. The red light "ON" indicates that the automatic control relay is in operating position and the column is providing a power load to the motor generator.

The possibility of a pressure loss in the column occurred to Elmlinger and Fleischman. They immediately checked the air monitors and observed that a slight rise in tritium had occurred in the room. Peak concentration was seven microcuries per cubic meter of air, as shown on the room monitor. The hood monitor showed no indication of an increase of tritium concentration. (The air sampling port in this hood was not drawing a sufficient volume of air.) Elmlinger, realizing there was a leak and that the arc must have burned through the column wall, asked Fleischman to check the pressure of the column. The dial manometer indicated that the pressure was decreasing and was approximately at atmospheric pressure. Before the failure, the pressure in the column was at least 886 millimeters of mercury as noted in the "daily column log."

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Report of Accident Investigation (Continued)

Photographs #4 and #5 show one of the two holes caused by the arc, which burned through the 0.035 inch thick Fernico tubing just above the glass-to-metal seal.

A fire was then observed in the hood near the base of the column. The arcing and resultant burn-through of the Fernico tubing at the base of the column apparently caused molten slag under slight pressure from column gas to spew out onto some rubber gloves and cotton glove liners lying on the floor of the hood. A smoldering fire resulted. Photographs #1, #2 and #3 show the glove liners and rubber gloves which had been left in the hood by personnel who had installed a new center wire in another thermal column adjacent to the "F" column several hours prior to the accident. These photographs show the extent of burning of the liners and gloves, as well as the mercury which had spilled through the hole in the tube caused by the arc.

The presence of mercury on the hood floor and in the lower terminal block around the glass-to-metal seal indicated a rupture in the bellows assembly at the top of the column. See Sketch #1.

Donald Spangler, who was in SW-6 at the time of the incident, observed Fleischman's signal of the emergency. Spangler entered SW-8 and secured the nearest CO_2 fire extinguisher, which was located near the control panel. He opened the door at the base of the hood and emptied the entire contents of the extinguisher onto the smoldering fire. He called for more fire extinguishers and used a total of three small and one large extinguishers on the fire. The action of the CO_2 extinguishers blew the smoldering glove liners about the hood. Because of the high air velocity through the opened door in the hood, it was difficult to effectively blanket the fire with a stream of carbon dioxide; however, the fire appeared to be extinguished.

In the meantime, Joyce Dauby left SW-8 to phone the Health Physics Department to obtain an estimate of the quantity of tritium discharged to the stack. The stack monitor recorder is located in the area Health Physics Office. Health

Physics reported that the stacking level was increasing and at that instant was past 10^5 microcuries per cubic meter of air. (Subsequent to the column burn-through, the stack concentration rapidly reached a peak concentration of 3.15 x 10^5 microcuries per cubic meter of air. The concentration then started to decrease.) Dauby re-entered SW-8 to discuss the accident with Elmlinger. Realizing the hazards of radioactivity, mercury vapors and fire, they decided to have the emergency alarm sounded. Dauby telephoned the emergency to Guard Headquarters at 1:40 P.M.

The members of the Emergency Brigade and the Health Physics Department responded to the alarm, reporting to SW-6 where they were briefed on the emergency. When it had been determined that the level of tritium in SW-8 was within the permissible 40-hour concentration, Dr. Lerroy Jones, Research Building Brigade Leader, entered SW-8 for preliminary inspection. When he ascertained that no immediate hazard existed, he phoned in the "All Clear" to Guard Headquarters at 1:45 P.M. At this time some of the brigade members, who were waiting in SW-6, entered SW-8.

It was then noted that smoldering had resumed in the glove liners. An additional CO_2 fire extinguisher was obtained and the smoldering fire was completely extinguished. An extension handle for a pair of forceps was hastily devised and used to rake the glove liners to a safe position near the center of the hood.

Soon after the accident had been reported, Spangler consulted with Dr. G. R. Grove, Research Section Leader. It was decided to flush out the gas still remaining in the column to eliminate the possible existence of an explosive mixture. A valve was closed on the feed side of the column, isolating the surge tank from the column. Most of the gas in the 25-liter raffinate collecting tank was transferred to an uranium bed and the remainder evacuated. Concurrently a 100-liter evacuated tank was attached to the raffinate system and interconnected with the collecting tank and column. The connecting line was also evacuated. Following evacuation, all three were allowed to equilibrate. When the pressure equalized, the contents of the raffinate collecting tank only were discharged to

the stack in order to repeat the flushing procedure. When approximately one-sixth of the contents of the raffinate tank had been discharged, as indicated by the pressure reading, the procedure was halted because of the high tritium concentration indicated by the stack monitor. After allowing time for the stack concentration to decrease, further discharge of the raffinate tank's contents was continued. Then, at the direction of Dr. Grove, stacking was ceased and the column and raffinate tanks were again equilibrated.

The Health Physics "B" Building stack monitor showed a total of 1,082 curies of tritium exhausted to the atmosphere. Eighty-five per cent of this loss was stacked from 1:30 P.M. to 4:00 P.M. The remaining 15 per cent "bled off" over the ensuing four-day long holiday week end. The loss includes the tritium which escaped under pressure, that intentionally stacked, and diffusion losses.

The estimated cost of the accident is as follows:

A.	1,082 curies of tritium	$ 790.00
B.	Recovery of tritium from 100-liter tank	25.00
C.	Damage to "F" column components	250.00
	TOTAL	$1,065.00

An electrical check of the external electrical hook up which includes the motor generator, control panel and electrical leads to the center wire, under a megger test of 500 volts, indicated 30 megohms resistance. This showed the external electrical system to be free of any unintentional ground connection. The center wire is presently intact but electrically grounded as shown by an ohm meter test. It is impossible at this time to determine definitely the location of the short circuit without dismantling the column.

III. Conclusions

The design of the "F" column has an inherent weakness in utilizing mercury in a bellows system at the top of the

column. The accident apparently occurred as a direct result of mechanical failure of the bellows in the upper assembly of the column allowing the mercury to drop into the column. Somewhere above the lower assembly an unintentional electrical ground already existed or occurred as the result of the falling mercury. This ground established an electrical potential across the bottom glass-to-metal seal. When the mercury filled the lower assembly to a point where the surface of the glass seal created a conductive path, an electrical arc followed this conductive path to the column wall. The sustained arc burned through the Fernico wall of the column just above the glass-to-metal seal. Another design weakness is the weight system employed on the upper end of the column to keep the center wire taut. If a mechanical stop were used to limit the travel of the weight, breakage of the center wire would not result in possible damage to the bellows assembly by sudden excessive stress.

No personnel in the area at the time of the incident received an internal radiation exposure of a maximum permissible body burden level as determined by bioassay procedures. The hood surrounding the "F" column prevented excessive escape of tritium into the room atmosphere, thereby protecting personnel and limiting contamination in the area.

The inoperative condition of the "F" column has resulted in continuous down time from the offset of the accident with regard to scheduled activities.

The cost of equipment damages due to the arc and resulting fire were nominal.

Rehabilitation of the "F" column would require the elimination of the unintentional ground (which might entail the replacement of the entire upper assembly and the electrical insulators spaced the length of the column); replacement of the lower glass-to-metal seal and lower assembly; and elimination of the use of mercury as the coolant in the upper bellows assembly.

The hood monitor did not indicate a rise of tritium concentration in the hood atmosphere. This indicates a malfunction

or insensitive condition of the monitor sampling tip in this hood.

The fire which occurred involving glove liners was incidental but it offered a serious potential due to the possible existence of an explosive mixture of the hydrogen isotopes with air. The emptying of the contents of four CO_2 extinguishers without completely extinguishing the small fire points up the ineffectiveness of this type extinguisher in this hood.

IV. Recommendations

A. The resumption of operations is dependent upon repair or replacement of the "F" thermal diffusion column. In view of the design shortcomings previously discussed, the continued operation difficulties which have prevented the realization of the "F" column's full potential (see secret document #60-12-48), and the anticipated difficulty of rehabilitating the "F" column from the maintenance and health physics standpoint, since the column construction does not lend itself to replacement of internal column parts, the committee recommends that the "F" column be replaced with a column of Mound design. The operational history of Mound columns has been considerably better that that of the "F" column.

B. Revamp the hood monitor system to obtain adequate and equal sensitivity of air sampling in the thermal column hood as well as in the "A" and "B" hoods. This may require an additional Kanne System.

C. Provide a hood exhaust monitor and recorder in SW-8. Locate the recorder so it is observable from SW-6.

D. To minimize the discharge of tritium to the environment, consideration should be given to a system to recover accidental or intentional loss of this material. (Such a system could utilize a manganese-copper oxide bed to convert the gaseous isotope to

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water, which then could be collected in a "Zeolite" bed.) See note below.

E. An emergency evacuated gas collection tank should be kept on hand at all times to be used for emergency conditions such as experienced in this incident.

F. Procure another type of non-aqueous fire extinguisher which is effective in well-ventilated hoods.

G. The provision of a suitable trash collection container will considerably improve housekeeping in this hood.

NOTE: The committee has been informed that the recommendation in D above has been under consideration for a period of time, but wishes to include the recommendation for the sake of completeness and to further emphasize the need.

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Report of Accident Investigation (Continued)

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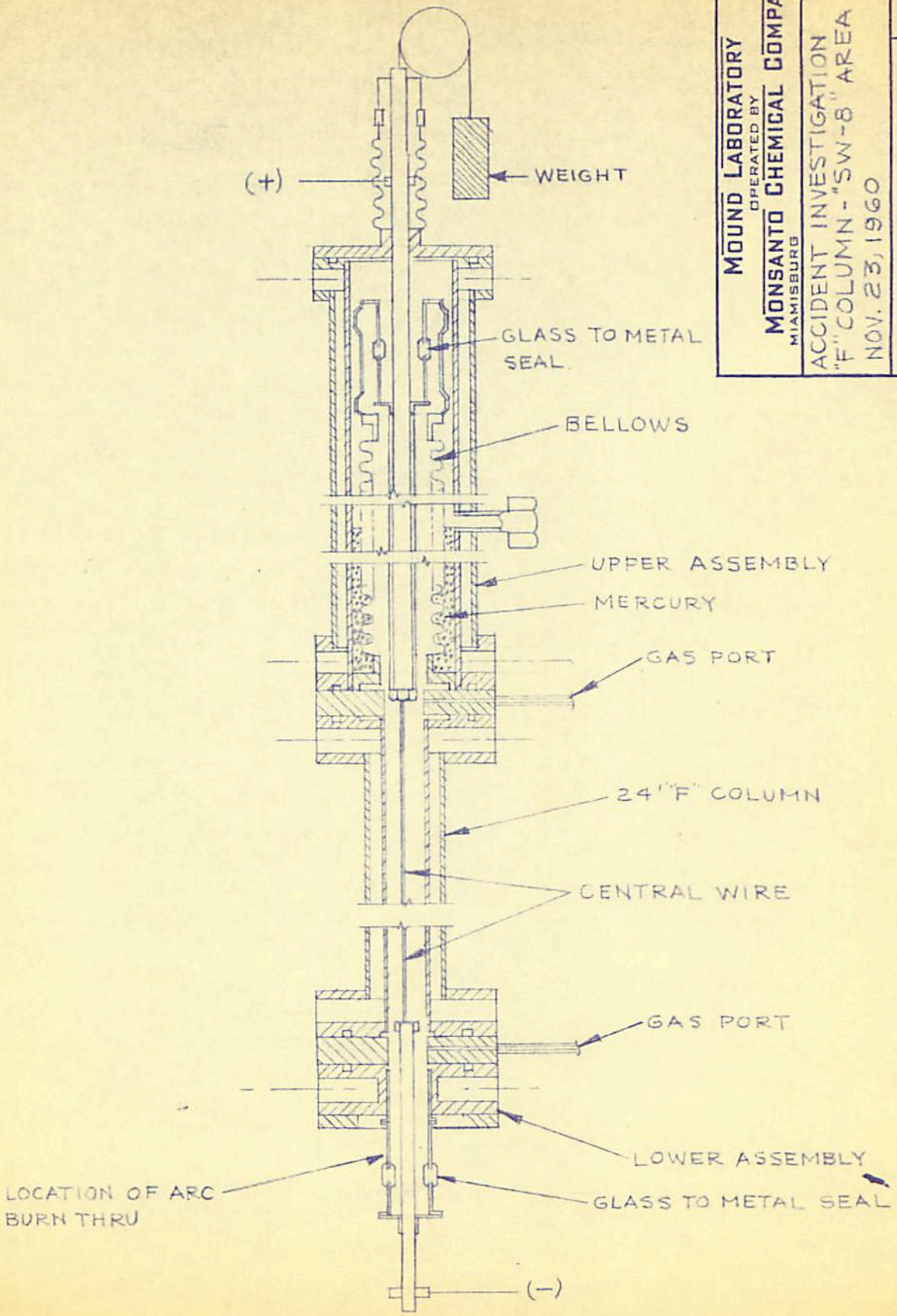

MOUND LABORATORY
OPERATED BY
MONSANTO CHEMICAL COMPANY
MIAMISBURG OHIO

ACCIDENT INVESTIGATION
"F" COLUMN - "SW-8" AREA
NOV. 23, 1960

APPROVALS
DRAWN ____ DATE ____ 1
CHECKED ____ DATE ____ 2
APPROVED ____ DATE ____ 3
JOB NO. ____ 4
SCALE

DWG. No. 1-SKETCH #1

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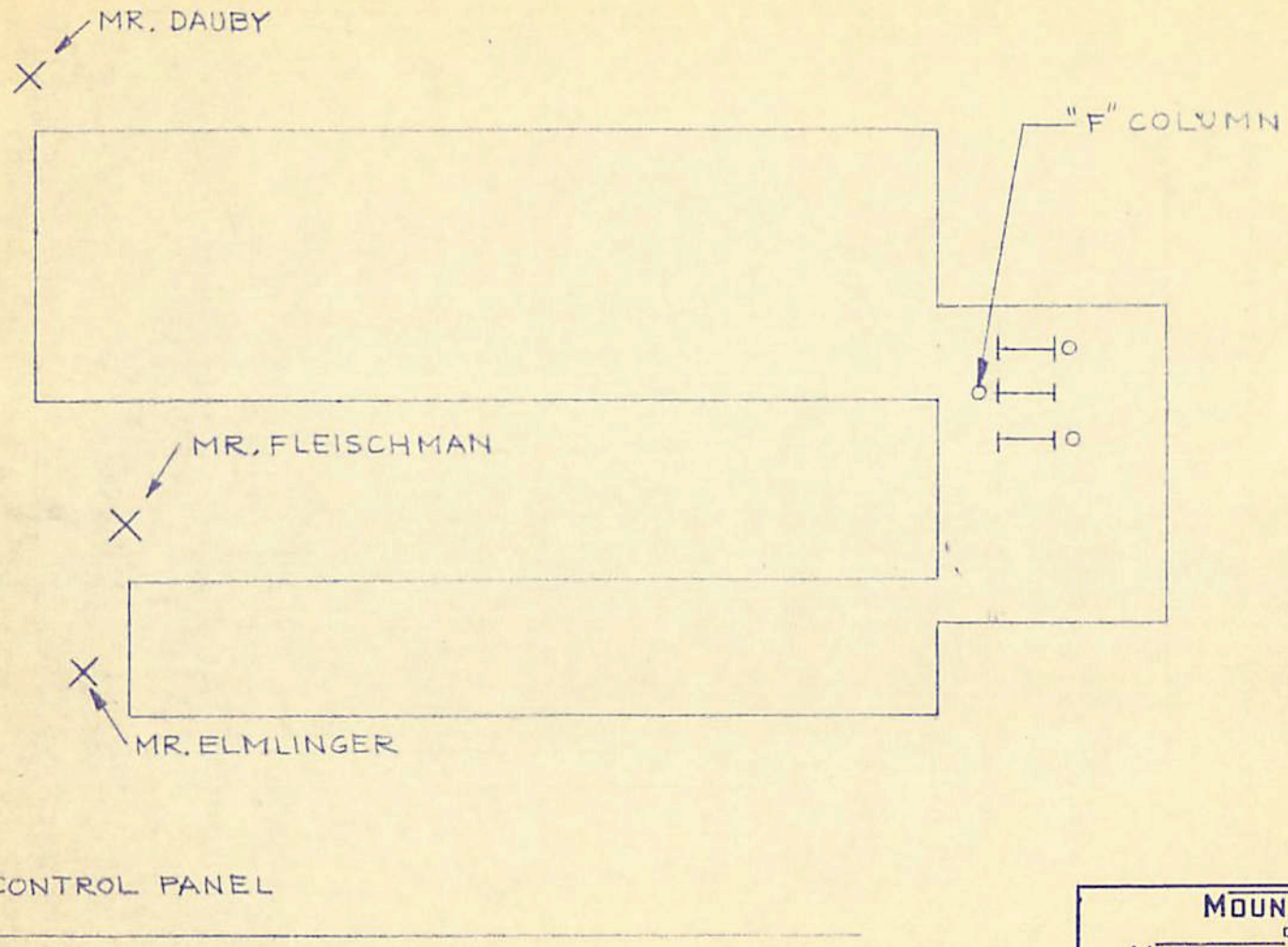

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ACCIDENT INVESTIGATION
"F" COLUMN - "SW-8" AREA.
NOV. 23, 1960.

DRAWN	DATE		APPROVALS
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PHOTO #1

PHOTO #2

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PHOTO #3

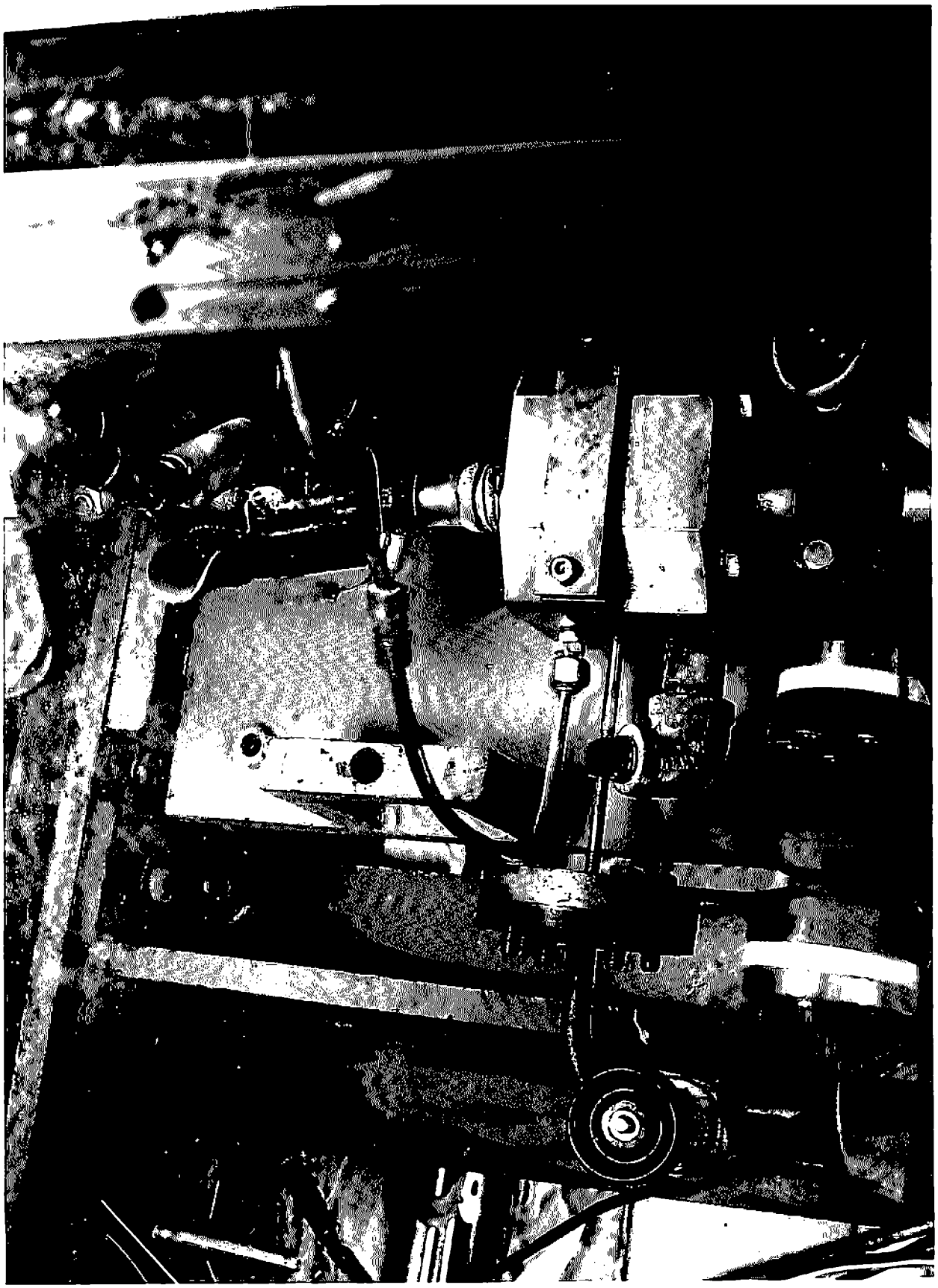

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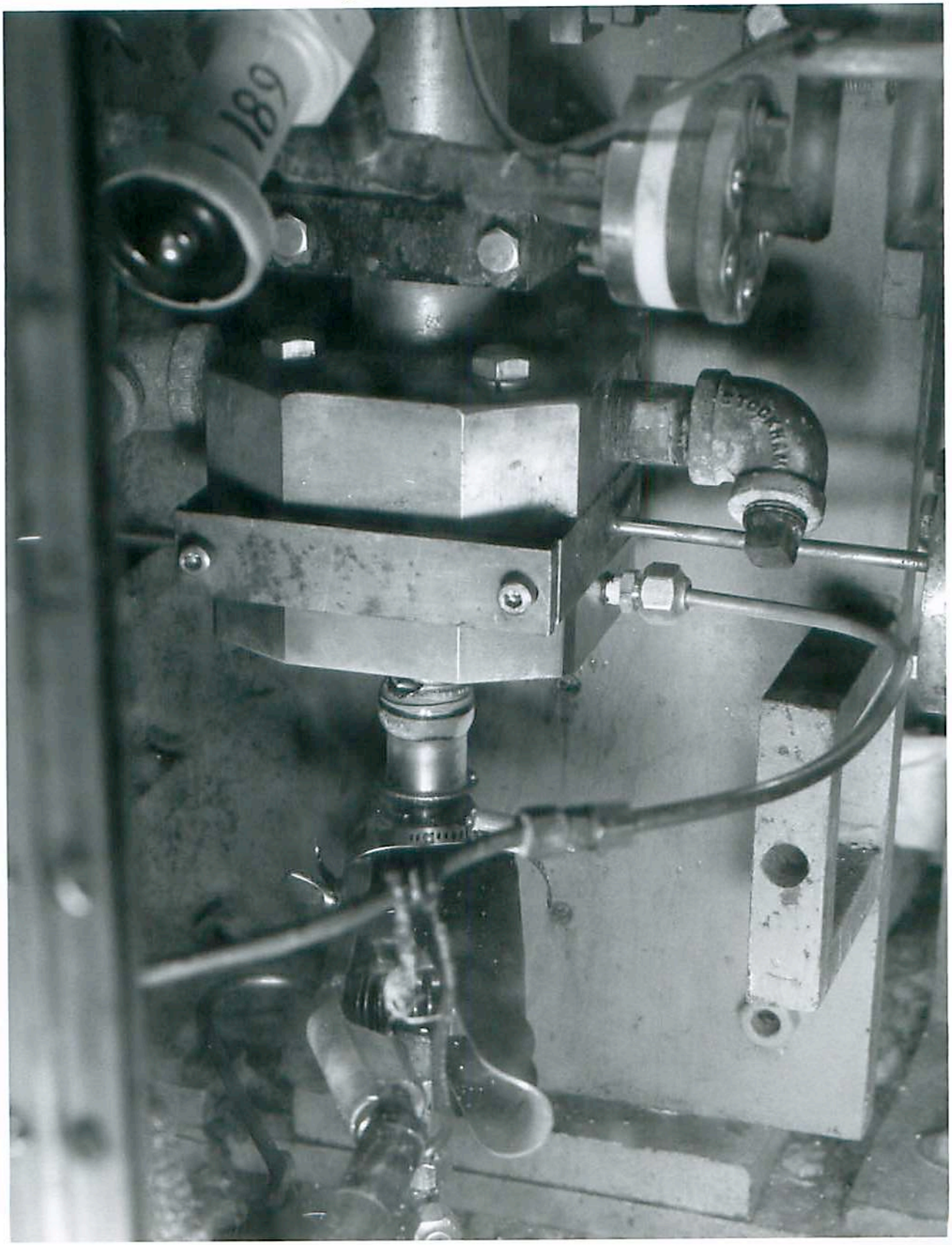
PHOTO #4



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