

Good morning, my name is Karl Oelfke. I am Production Manager at the Texas Division of Dow Chemical U.S.A. My area of responsibility includes the manufacture of vinyl chloride at the Texas Division. In addition, I am responsible for the coordination of vinyl chloride production techniques and technology for The Dow Chemical Company on a world-wide basis.

I would like to speak on Engineering Controls and Manufacturing Practices in both the production of vinyl chloride monomer at our three United States manufacturing sites and the copolymerization of vinyl chloride monomer at our manufacturing site in Midland, Michigan.

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The first part concerns vinyl chloride monomer (VCM) manufacture.

This is an aerial view of our oldest currently operating VCM plant in our Texas Division at Freeport, Texas. Commercial scale production of vinyl chloride was started here in 1948. Over the years, through what we have called incremental expansions, production capabilities have been increased by some 400%. You will notice that there is little separation of equipment and the close proximity of the control room to the processing area. The control room is at the middle left of the picture.

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You can get some idea of the size of the plant by noting the sizes of the cars in the photo.

Our second monomer plant came on stream in 1958 and is located in our Louisiana Division at Plaquemine, Louisiana. This plant has been incrementally expanded over the years and production capabilities have been increased by some 1,000%. Again, as a result of these expansions, you will note the congestion of equipment, but you will please also note the congestion is less than that shown on the previous slide.

Here we have our most recent vinyl chloride monomer plant located in our Oyster Creek Division at Freeport, Texas, and started in 1969. The most recent plant layout criterion was used at this plant and congestion is minimal. Here the control center is located at an increased distance from the process area.

I'm sure that if we were to design another vinyl chloride plant today, even more thought would be given to plant layout and design.

In earlier years, more concern had been for the hazards of fire and explosion of vinyl chloride. These hazards were the main causes for greater separation of equipment.

Typical of this concern is illustrated by flammable gas detector

alarms which are strategically placed in the plants to alert personnel in the event of a major leak or spill.

One other thing you might have noted is the trend in recent years toward large single "train" units rather than several smaller "trains."

Economically, this can be shown by the generalized formula that indicates that the capital requirements for a plant twice as large as the base unit is 2 to the .6 power. Thus, for 2 small plants, the capital required would be 2 x the base unit, but for a plant twice as large as the base would only cost 1.52 x the base unit. Capital abandonment of an existing plant in favor of a new facility of the same size and essentially the same technology is generally not done in the industry. Economics do influence this decision, such as the reduction in cost of manufacturing as the result of decreased maintenance cost, improved manpower, utilization, improved raw yields and lower freight costs.

From a health standpoint, these large single "train" units considerably reduce emissions because of the fewer number of pieces of equipment.

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What have engineering controls and techniques accomplished over the years in vinyl chloride plants, other than the large single train concept? And, how can these relate to vinyl chloride emissions in the workplace?

Let us consider for example, vinyl chloride recovery. In the thermal dehydrochlorination of ethylene dichloride, the cracking furnaces operate with a outlet pressure range of 20 to 400 pounds/square inch gauge. The lower pressures are usually used in the older plants and in plants that remove the by-product hydrogen chloride by absorption. The gases must then be compressed for purification. These types of systems are no longer being built in the more industrially developed countries because of the expense of operation. Reciprocating compressors without packing purges as the first generation, with packing purges as the second generation are being used in our oldest plant. Centrifugal compressors are being utilized in our second generation plants. One of these (a fairly recent technical development) can replace a number of reciprocating compressors, but here again, size and economics dictate any replacements. One plant with which I was associated some years ago replaced five 150 horsepower reciprocating duplex compressors with a 1,500 HP centrifugal compressor when the capacity of the plant was doubled. Even though the five 150 HP compressors

were high maintenance items, there was no way to economically justify replacement by a centrifugal compressor. Potential leaks are reduced many fold using centrifugals instead of reciprocating. Elimination of the compression step is the best solution and this has been accomplished at our most recent plant.

Okay, new plant design and construction has the potential for significantly reducing vinyl chloride exposures in the workplace through such things as plant layout and elimination of equipment. However, from the pictures you have seen that the plants are large and complex with many valves, pumps, and flanges. Consequently, the complete elimination of leaks even in a foreseeable new plant is not technically feasible.

What can be done using engineering control and workplace practices to reduce emissions in existing vinyl chloride monomer plants? First, I would like to emphasize that essential to engineering controls and workplace practices is the identification of problems through workplace monitoring. This can be accomplished by analyzing grab samples of air from various locations, by using personnel monitoring techniques based on carbon adsorption, carbon disulfide extraction and gas chromatography, and by area monitoring. Using these techniques, problem areas were identified. To illustrate what can be done, I will now describe several of

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these problem areas and the engineering and work practice methods used to reduce emissions.

Tank Car Loading - It has been industrial practice for many years to gauge tank car innage on pressure cars using vented slip tubes as shown here. The level of the liquid in the tank car is determined by observing for liquid or gas flow from this tube. Freight bills are based on weights of products shipped. Pressure car minimum rates are calculated for 98% of allowable. For this reason, we want to fill tank cars between 98 and 100% of allowable. These gauging devices are set when the temperature of the vinyl chloride inside the tank car has been determined. Normally they are set at 90% of allowable so that when the car has been filled to that level, the loading person can see that the loading is almost finished as the vinyl chloride liquid spewing from the opening creates a short-lived fog (but an emission and potential exposure point). He then readjusts the slip tube to 98% level and tops off the tank car. Even though the 8-hour TWA was below 50 ppm as determined by personnel monitoring, steps are being taken to eliminate this emission. For the long-term solution, magnetic gauging devices are being secured and installed. It is estimated that all of the vinyl chloride tank cars that Dow fills will be equipped with this type gauging device by the end of 1975. An interim solution is being sought at this time. Tests are being conducted using a temperature sensing device in a closed loop

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system. This device has had limited testing, but it looks very promising. Disconnecting loading and vent lines from tank cars was another exposure problem. The exposure potential has been lessened through purging the liquid and vapor lines into the tank car with nitrogen.

In-Plant Sampling. - Process and quality control samples are a must in the vast majority of chemical production plants. On stream analyzers are the preferred method if at all possible. In some analyses, on stream analytical technology has not been developed. Sampling of the process streams has to be done. Again, with personnel monitoring as our guide, these problem areas were brought to our attention. This is a picture of the old method, the picture was posed. Here we see a closed loop sampling system developed to decrease potential personnel exposure. Both cylinders are evacuated at the laboratory. (The vacuum pump vents to a hood stack.) The sample cylinder is at the bottom, the waste cylinder is at the side. Vinyl is purged from the liquid line at the top, through the cross and out the flexible line at the left. The flexible line is closed and the sample cylinder filled. The valves are blocked from the liquid line and at the cylinder. Prior to disconnection, the waste cylinder (under vacuum) is opened to evacuate the sample header. Considerable potential exposure was eliminated.

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Analytical - Personnel monitoring results of our laboratory personnel caused us to study more in depth the job make-up. Wet methods of analysis at one time were performed in the laboratory, but outside the hood. As a result of the monitoring, these analyses are now performed under the hood. Further monitoring indicated that this method of transfer was not satisfactory (hood door raised), although better than previously experienced. This is the method we now use (hood door closed). Unused sample portions are returned to the process.

As we worked on our areas, even though exposures were not necessarily being experienced (they probably were) other problem areas were seen.

In-plant - Header systems such as this pump drain line, reboiler drain line, and vapor recovery units are being installed to return vinyl chloride containing streams to process when maintenance work must be performed. At present, only that equipment requiring frequent maintenance is so headered, such as pumps, reboilers, and filters. Operating procedures were changed to require purging of liquids from lines using nitrogen prior to maintenance.

As you have seen, engineering controls and workplace practices can reduce the potential exposures of our employees working in monomer production, but again I should emphasize that a monitoring system is essential to locate the problem areas.

What about vinyl chloride exposures in polymerization plants? What has Dow done to reduce the exposure potential?

Our most recent polymerization plant in Midland, Michigan was constructed with separation and protection of the major processing phases in mind to minimize potential capital loss. The separation also tends to reduce the potential personnel exposures. Compare this most recent installation with the original plant. You will note the original plant was completely inside a building, while the newest plant utilizes more open construction, even though it is built in the cold North. Vinyl chloride is unloaded into a tank farm some distance from the processing area.

The new polymerization areas are highly automated, using sophisticated computer equipment. The areas were designed and constructed to include: no precessing system open to the atmosphere; minimum monomer storage in the polymerization area; minimum number of monomer transfers; no routine opening of monomer lines; larger capacity equipment and a minimum number of vessel openings and entries. We are also testing canned or sealless pumps.

The polymerization control rooms are pressurized with fresh air and are continuously monitored for vinyl chloride.

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Extensive inline or onstream instrumentation is used (this is a conductivity cell) to minimize the need for taking process samples containing vinyl chloride. Where monomer samples are required, a closed loop system is used. Here the sample cylinder (still containing the residue from the last analysis) is connected to the liquid line on the left and to a vacuum line on the right. The valves are arranged to flow through the cylinder. The cylinder valves are closed as well as the sample point. The vacuum line is opened to the left end of the cylinder. This allows both ends of the cylinder to be evacuated prior to removing it. This is in contrast to past sampling procedures (this picture was posed).

At the present time, even with the best designed system, it is occasionally necessary to open lines and equipment which have been in vinyl chloride service. In these cases, piping provisions have been made to allow draining the monomer, flushing with a non-hazardous material and purging with an inert gas before opening to the atmosphere.

In our polymerization plants, just as in our monomer plants, lower explosive limit alarms are located throughout the plant to detect major spills and leaks should they occur.

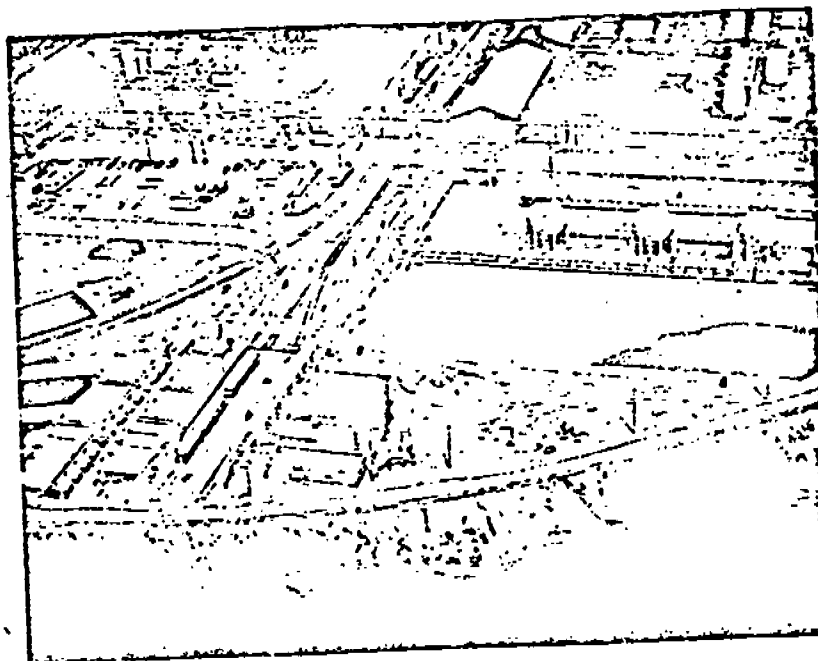
As will be presented in our testimony on monitoring, we've

come a long way in reducing vinyl chloride exposures of our employees through engineering techniques and workplace practices; and, as technology improves, we will further reduce these potential sources of exposures. However, from a practical standpoint, the technology does not now exist to eliminate all sources of emissions in these large complex plants.

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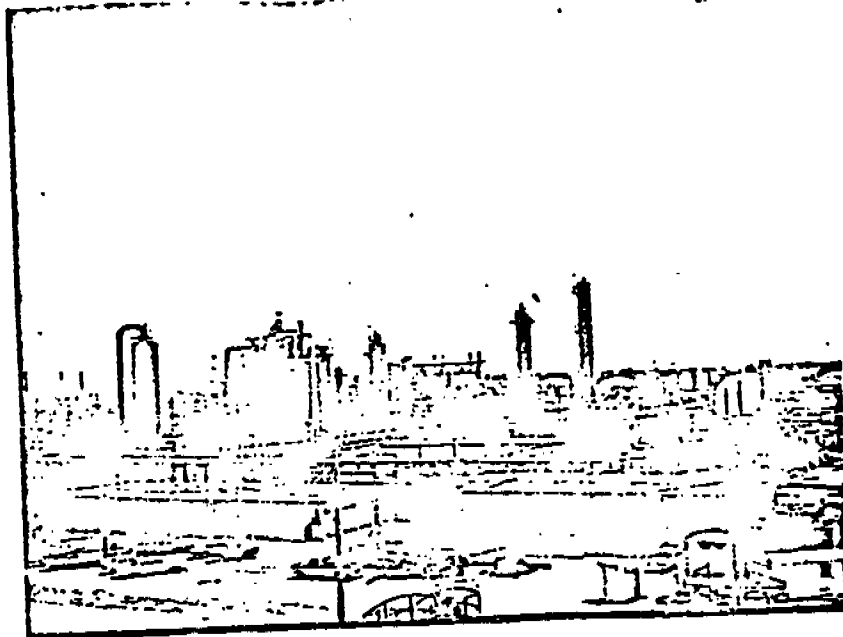


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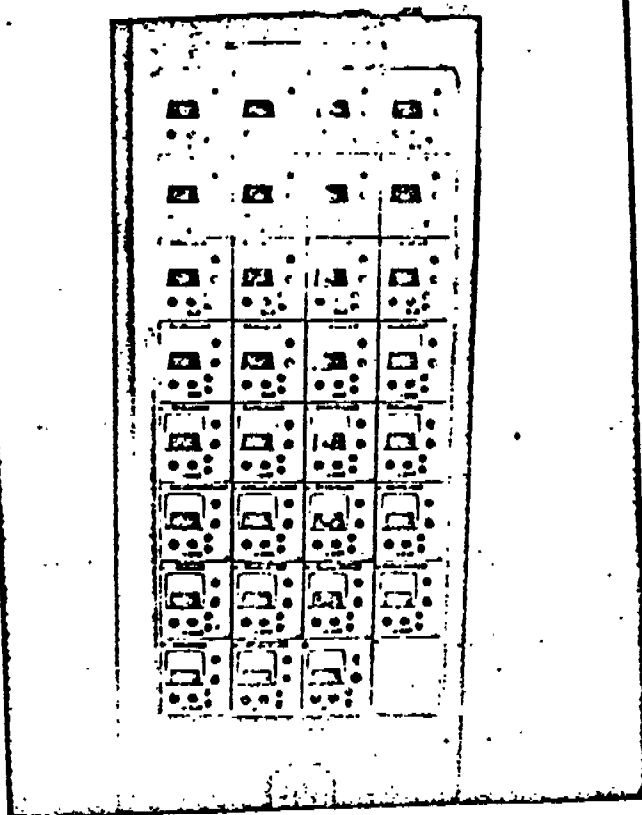


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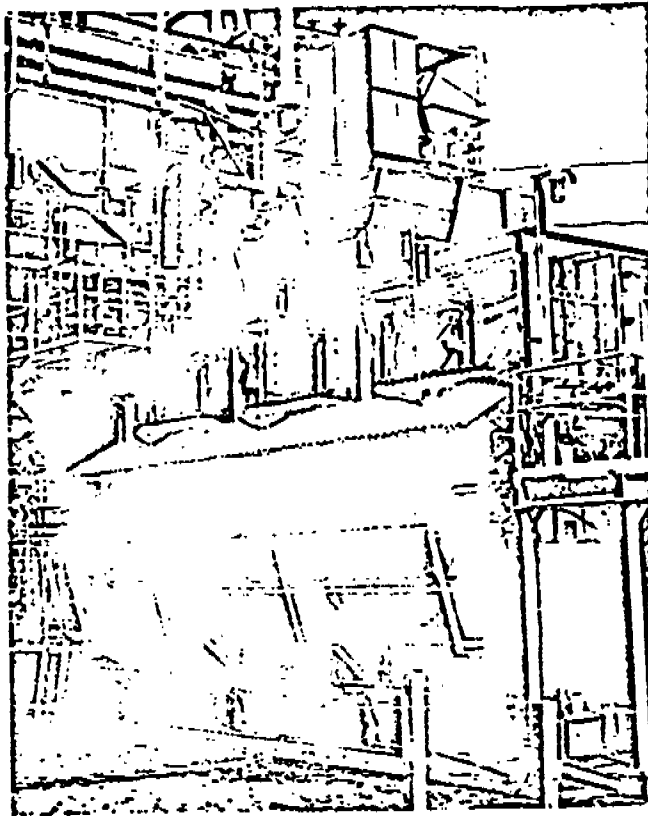


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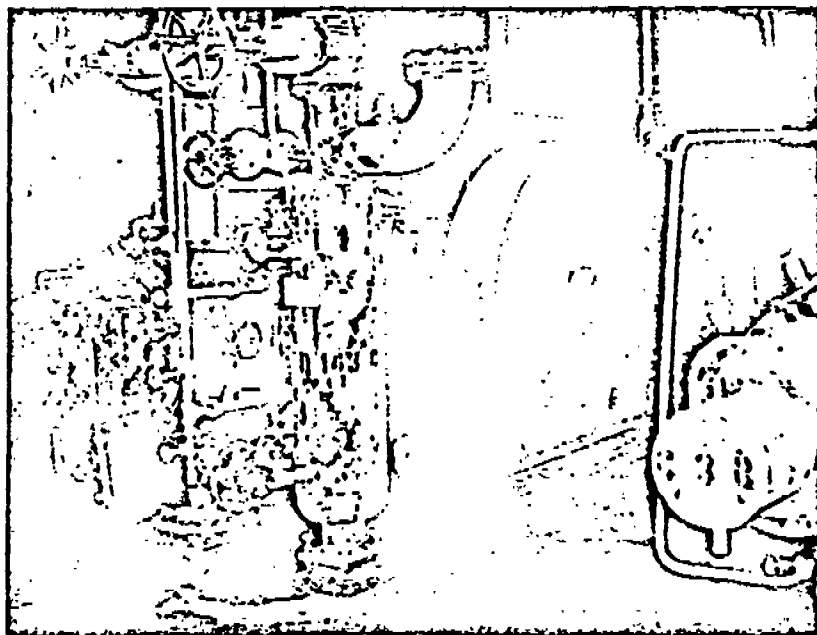


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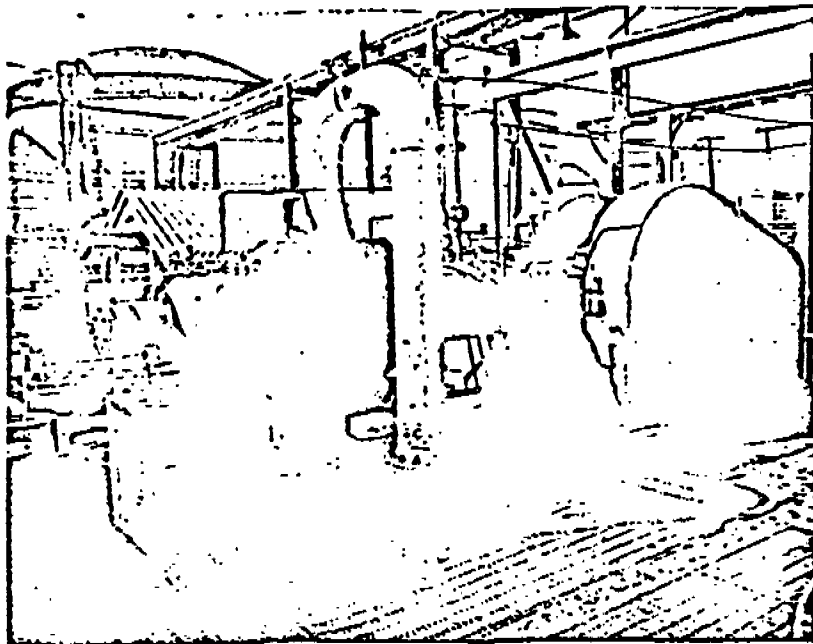
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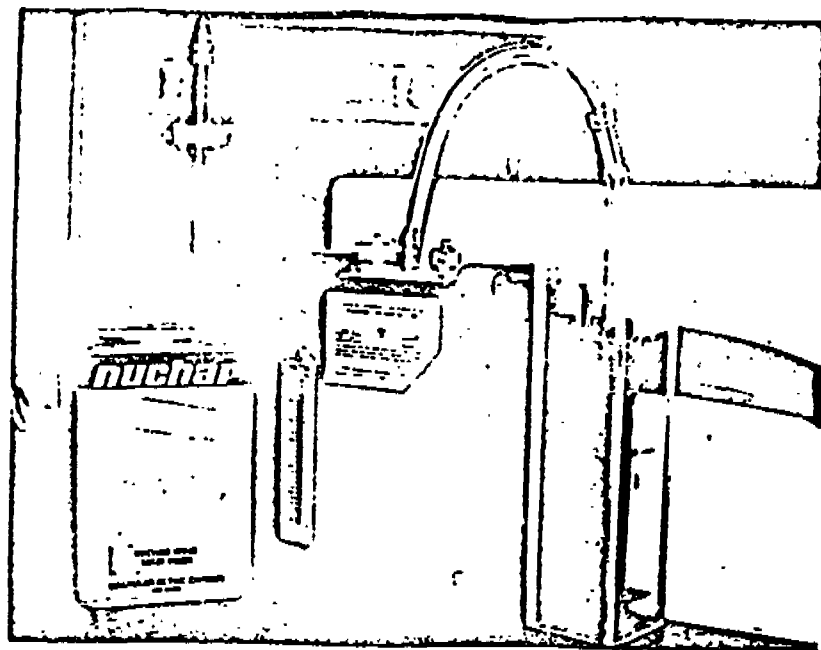


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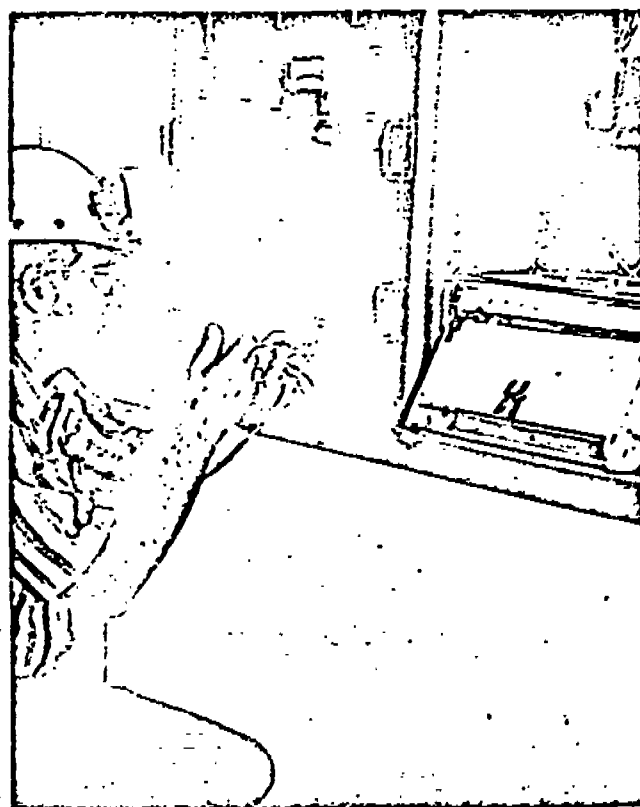


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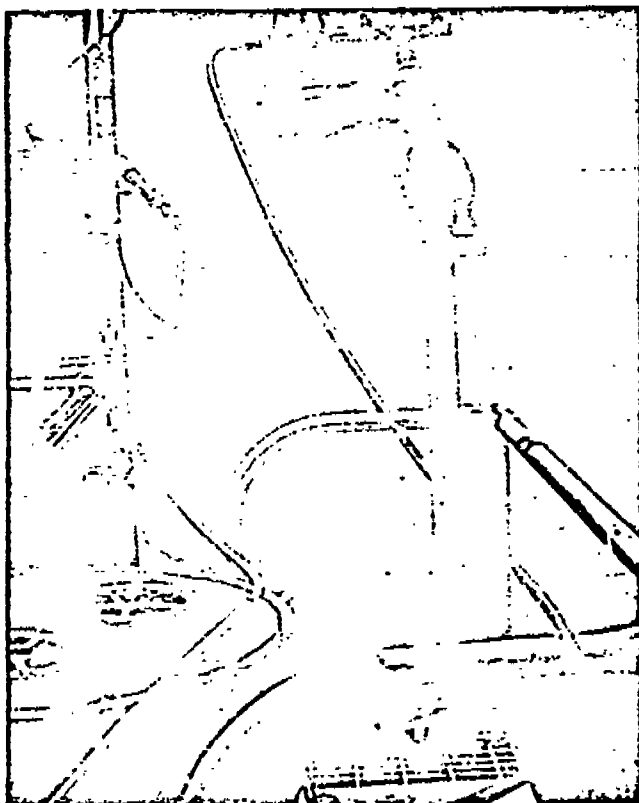
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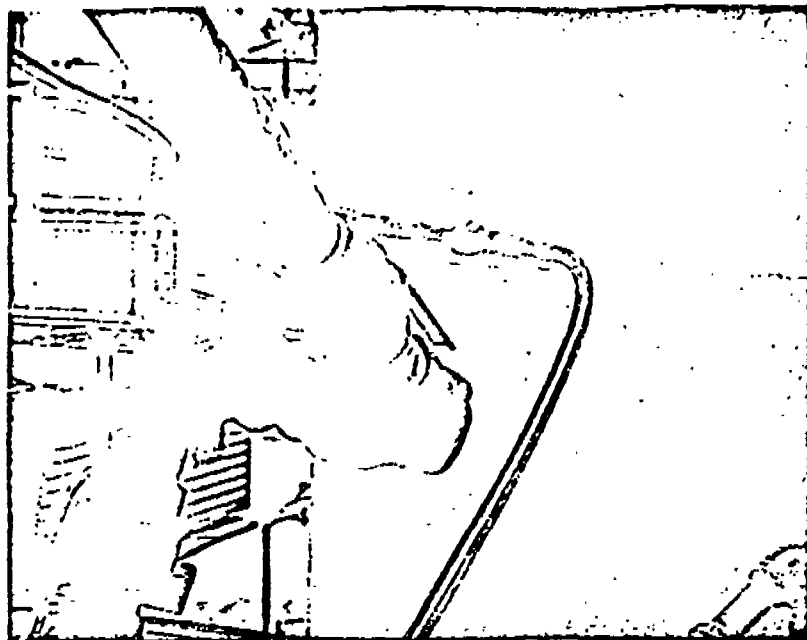


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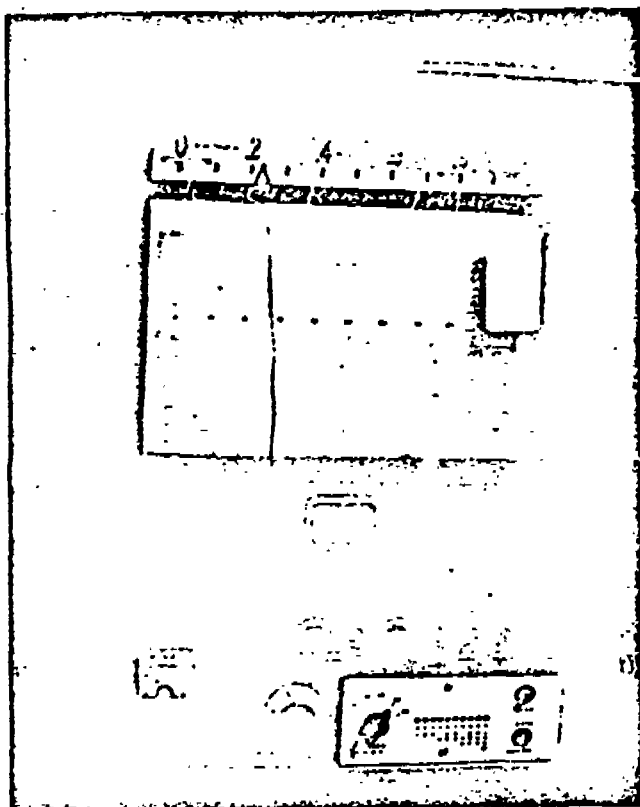


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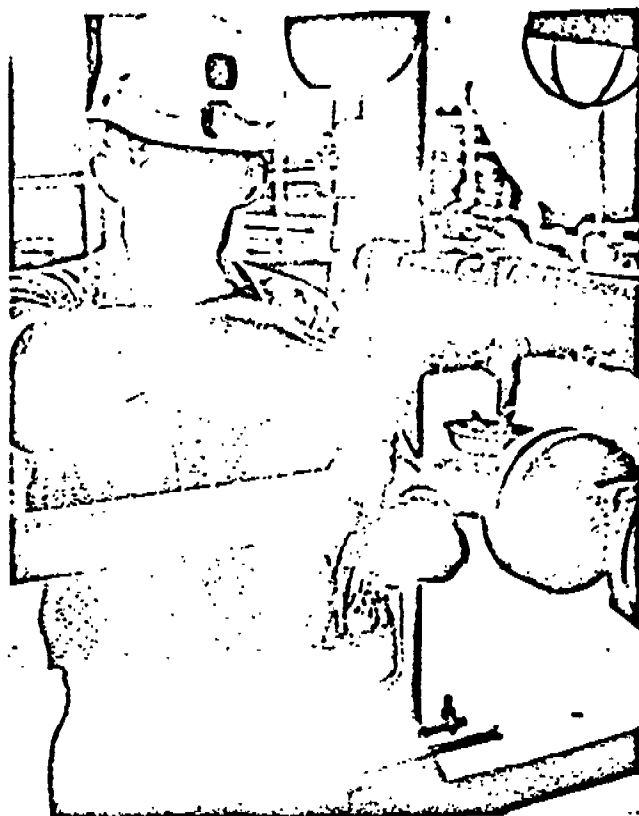


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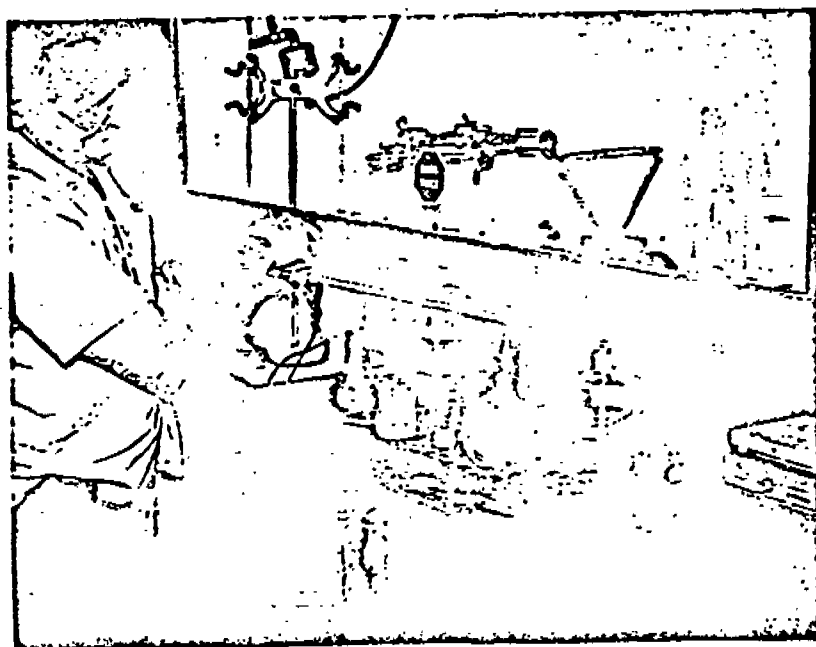


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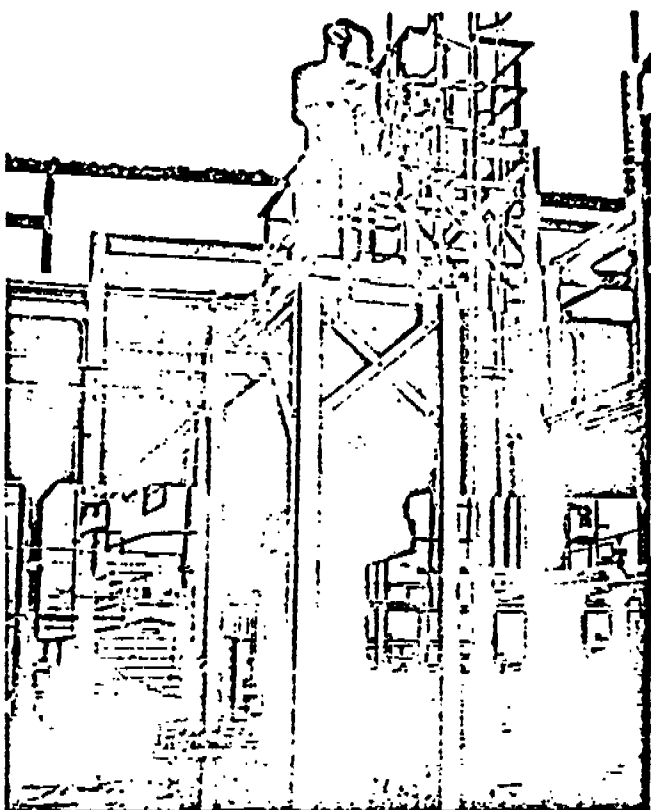
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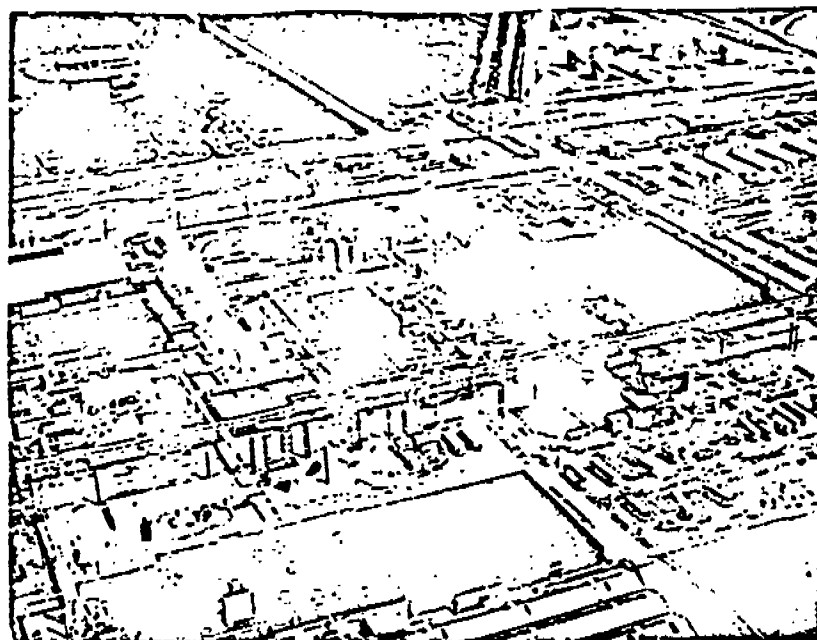


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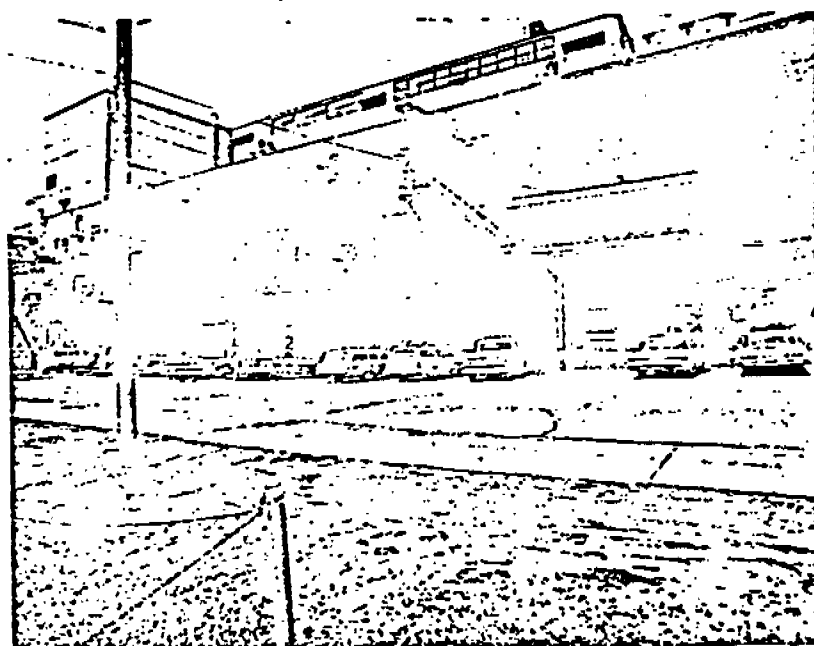


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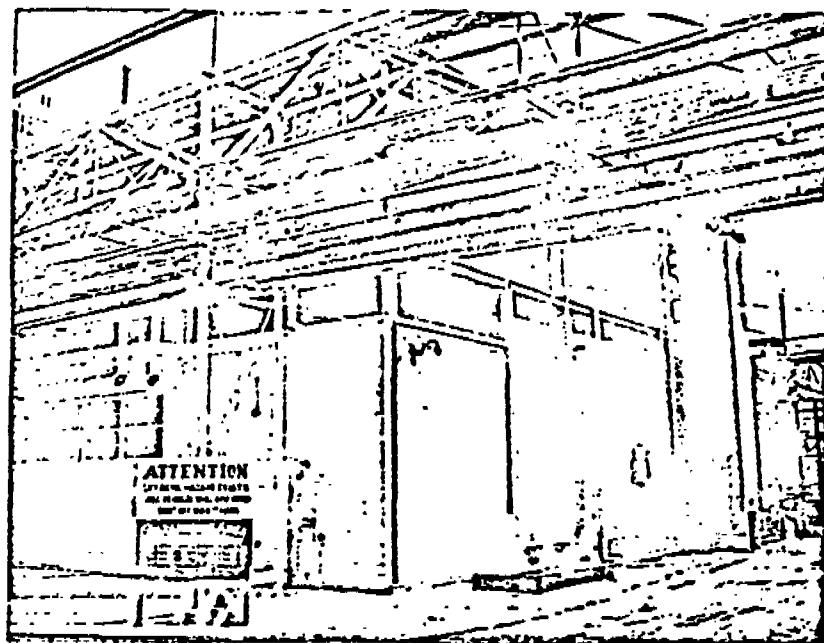
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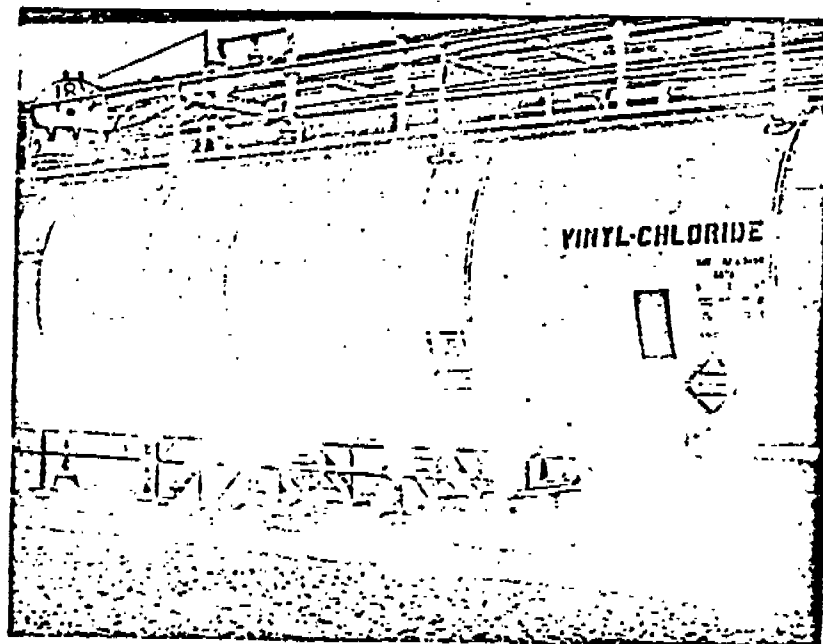
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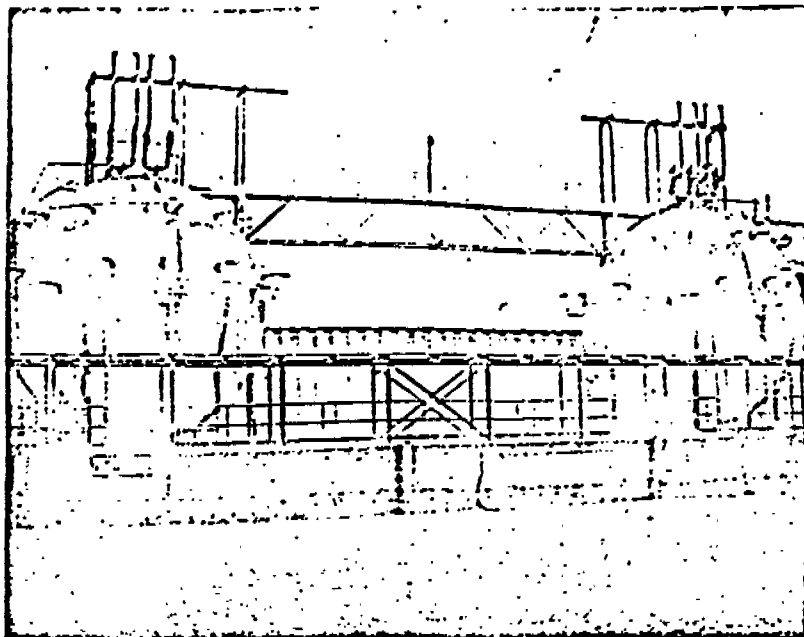
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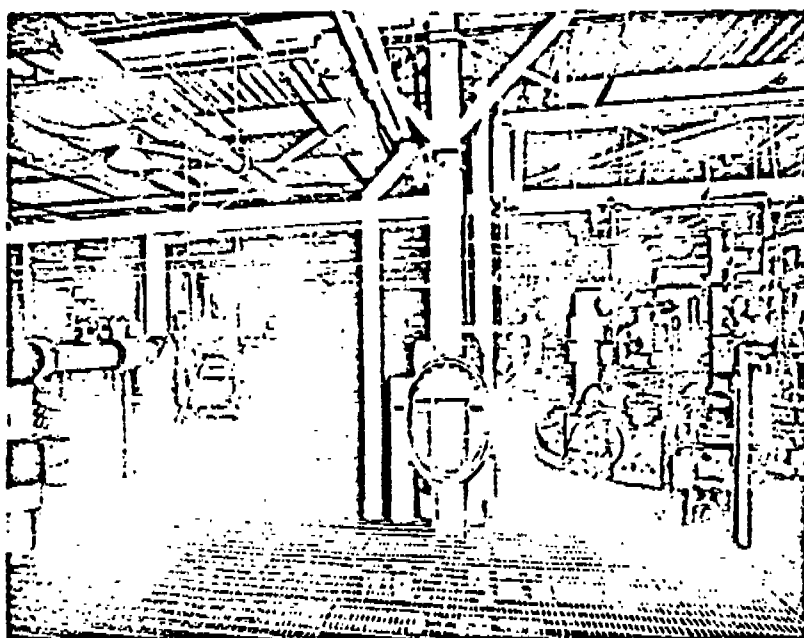
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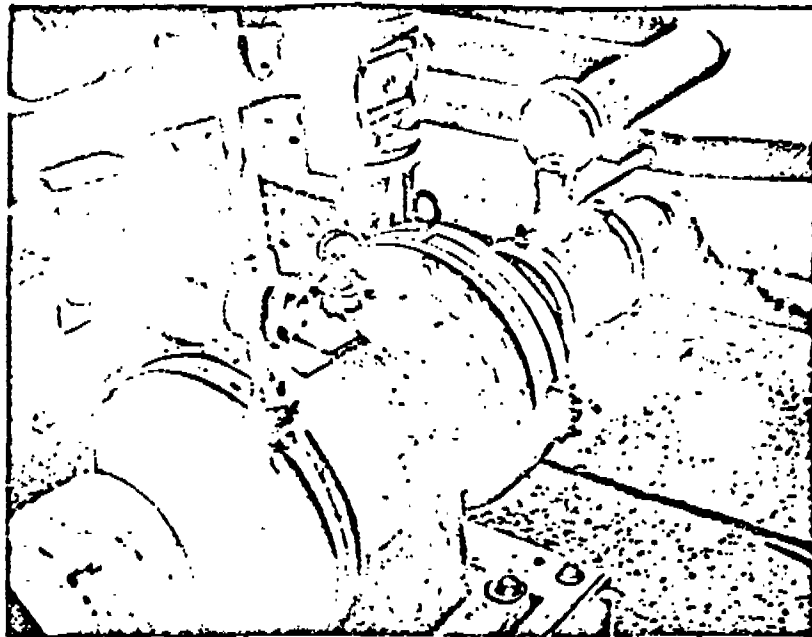


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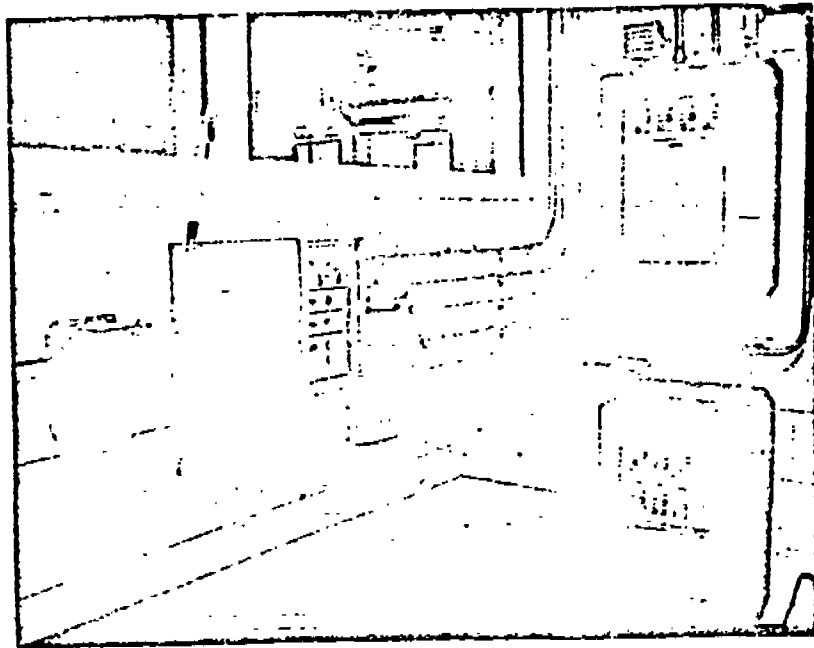


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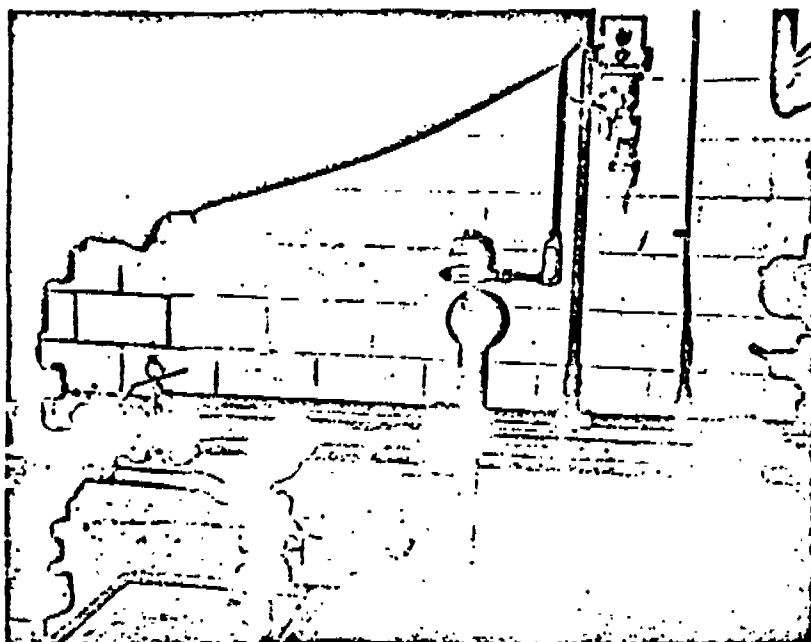
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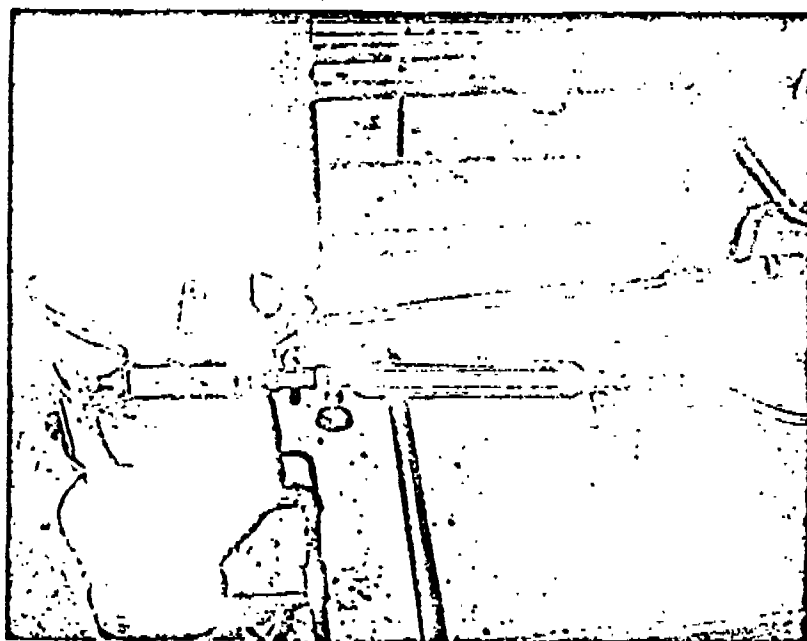
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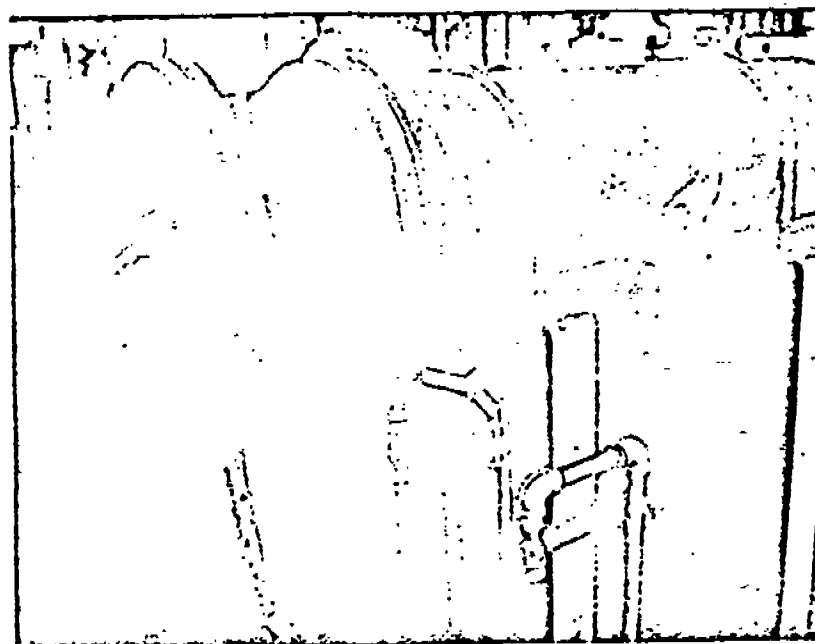


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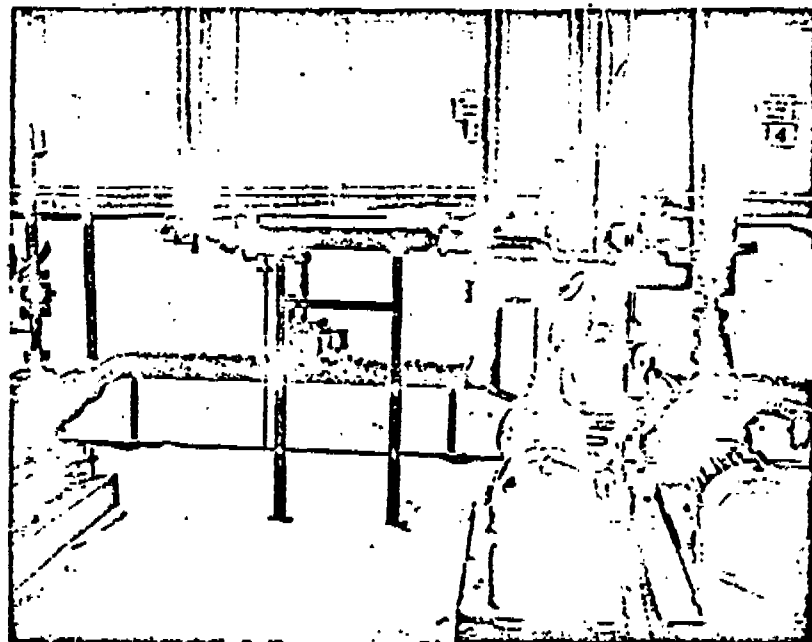
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I WOULD NOW LIKE TO INTRODUCE MR. ROGER DANIEL, MANAGER OF INDUSTRIAL HYGIENE FOR OUR TEXAS DIVISION. MR. DANIELS WILL DISCUSS THE PRINCIPLES INVOLVED IN AREA AND PERSONNEL MONITORING AND THE SIGNIFICANCE OF SUCH DATA IN DESCRIBING THE EXPOSURES OR POTENTIAL EXPOSURES OF WORKMEN. HE WILL ALSO DISCUSS THE USE OF VARIOUS MONITORING TECHNIQUES IN DETECTING JOBS WHERE PROTECTIVE DEVICES ARE NECESSARY, IN LOCATING SOURCES OF RELEASE OF VCM SO THAT PROMPT MAINTENANCE CAN BE INSTITUTED AND EXCAPE OF MATERIAL AVOIDED.

ROGER

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