GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No. A-3712 GTRI/~~GIT~~ DATE 12 / 9 / 83

Project Director: Dr. Wallace Shakun/James M. Lefferdo ~~School~~/Lab EMSL

Sponsor: T-Drill, USA

CO

Type Agreement: Standard Research Project Agreement No. A-3712

Award Period: From 12/1/83 To ~~4/15/84~~ 4/30/84 (Performance) ~~4/15/84~~ 4/30/84 (Reports) 5/30/84

Sponsor Amount: This Change 5/30/84 Total to Date

Estimated: $ 12,204 $ 12,204

Funded: $ 12,204 $ 12,204

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: "Fluid Flow Characteristics in Various Sections"

ADMINISTRATIVE DATA OCA Contact Lynn E. Boyd ext. 4820

1) Sponsor Technical Contact:

Mr. Heikki Savikko
General Manager
T-Drill, USA
4357- B Park Drive
Norcross, GA 30093
(404) 925-0520

2) Sponsor Admin/Contractual Matters:

Defense Priority Rating: _____ Military Security Classification: _____

(or) Company/Industrial Proprietary: _____

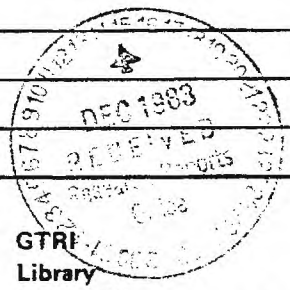
RESTRICTIONS

See Attached _____ Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with Sponsor but none proposed.

COMMENTS:



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FORM OCA 4:383

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 6/25/84

Project No. A-3712 School/Lab EMSL

Includes Subproject No.(s) _____

Project Director(s) Dr. Wallace Shakun/James M. Lefferdo GTRI /XXXX

Sponsor T-Drill U.S.A.

Title Fluid Flow Characteristics in Various Sections

Effective Completion Date: 5/30/84 (Performance) 5/30/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. _____ Continued by Project No. _____

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Form OCA 60:1028

A-3712

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

May 28, 1984

Mr. Savikko
T-Drill-Atlanta
4357-B Park Drive
Norcross, Georgia 30093

Dear Mr. Savikko:

Enclosed is the letter report closing out contract No. A-3712-000 "Fluid Flow Characteristics in Various Tee Sections." Included in the report are figures which are color prints of slides taken during the program. If you would like these slides please contact me.

Sincerely,

R. L. Roglin
Energy and Materials Sciences
Laboratory

jw

Enclosures

cc: J. Lefferdo
W. Shakun

"FLUID FLOW CHARACTERISTICS IN VARIOUS TEE SECTIONS"

FOR T-Drill - Atlanta

Contract No. A-3712-000

May 28, 1984

R. L. Roglin
Georgia Institute of Technology
Energy and Materials Sciences Laboratory
Atlanta, Georgia 30332

I. INTRODUCTION:

The scope of this project entailed preforming a hydraulic test on six different tee type piping components. The output from the test is of the form of pressure drops across the tee being tested. This output is then used to calculate flow velocities and friction losses of the water passing through the tee being tested.

II. TEST APPARATUS:

Before the test could be run a test apparatus had to be designed and constructed. Design constraints were provided by T-Drill as to the velocity of the flow entering the tee being tested. Piping components included in the test apparatus were schedule 40 pipe, standard 150 # flanges, orifice flanges, valves, two 500 gallon surge tanks, and a differential pressure meter. A layout drawing is shown in Figure 1. Photographs of the test site and layout are shown in Figures 2 to 7. A manifold device tooled by T-Drill was used in the data acquisition so that one meter could be used to measure all the required pressure differentials. Photographs of the manifolds are shown in Figures 8 and 9. (Figures 10, 11, 12 are the 6" butterfly valve, the 6" globe valve and a 6" orifice flange)

III. TEST PROCEDURE:

The testing of each tee was done individually, first a 6 x 6 x 4 tee was tested shown in Figure 13, then a 4 x 4 x 2 tee was tested, shown in Figure 14. The tee being tested was isolated from the other tee through the use of two valves, one on the six inch line and one on the two inch line. When the 6 x 6 x 4 tee was being tested the two inch valve was closed so water would only be flowing in the six and four inch lines. When

the 4 x 4 x 2 tee was being tested the six inch valve was closed so water would only be flowing in the four and two inch lines. The six inch valve is labeled "V2" and the two inch valve is labeled "V3" in Figure 1.

The reason the tests were run this way was to insure that the flow velocities entering the tee were 7 fps into the larger tees and 6 fps into the smaller tees. These velocities were maintained with the use of the two 500 gallon surge tanks. These tanks one at the upstream end of the test apparatus and one at the downstream end of the test apparatus were kept at a constant head by pumping water from the downstream tank into the upstream tank. The required head on the upstream tank was calculated to provide the prescribed velocities and this head level was maintained through the entire test.

An individual test entailed the measuring of four pressure differentials. One across the inlet side of the run pipe (tap 1 and tap 2), one across the outlet side of the branch pipe (tap 5 and tap 6), one from the inlet side of the run pipe to the outlet side of the run pipe (tap 1 and tap 4), and one from the inlet side of the run pipe to the outlet side of the branch pipe (tap 1 and tap 6). The taps are labeled on Figure 1. The taps listed above in parentheses are for the testing of the 6 x 6 x 4 tee.

Five different tests, A to E, were run for each tee and the tabulated data from these tests is shown in Table 1. The data in Table 1 reflects only relative pressure differentials in inches of water from one pressure tap to another. This can be thought of as having a manometer at each tap and the inches of water pressure differential is the difference in elevation in inches of the water in two of the manometers.

TABLE 1

6 x 6 x 4	STANDARD TEE					NOZZLE					T-DRILL				
TAP	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1-2	22	23	18	18	18	21	21	21	21	21	14	13	20	21	21
1-4	13	16	15	15	15	19	19	19	19	19	14	10	13	15	15
1-6	10	11	10	10	10	9	9	9	9	9	9	7	9	10	10
5-6	3	3	2	2	2	1	1	1	1	1	1	4	1	2	1

4 x 4 x 2	STANDARD TEE					NOZZLE					T-DRILL				
TAP	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
5-6	22	23	22	22	21	25	26	26	26	25	26	26	26	26	26
5-8	44	44	43	43	42	30	32	33	32	32	28	30	30	31	31
5-10	27	28	28	27	27	33	33	33	32	31	32	32	32	32	32
9-10	15	15	15	15	15	14	15	15	14	14	15	15	15	16	15

IV. TEST RESULTS:

Flow rates were calculated for each leg of the tee being tested. These flow rates were calculated using the pressure differentials at the different taps and the total amount of head from the water in the upstream tank to the taps. Bernoulli's equation was used to calculate the flow velocity and the thin sharp edge orifice plate equation was used to calculate the flow rates. The calculation of flow velocities with Bernoulli's equation requires the use of head loss coefficients. Since there are no head loss coefficients available for the T-Drill component a parametric study was done to see the sensitivity of the flow calculation to

the head loss coefficient. This study showed a 1 percent to 1-1/2 percent variation in the flow calculation for head loss coefficients between 1.0 and 2.0, where the standard tee has a head loss coefficient of 1.8.

A comparison of the flow rates shows the standard tee to have the best flow characteristics, the nozzle to have the worst flow characteristics, and the T-Drill tee to be located between the two with flow characteristics closer to the standard tee.

A review of the data for the 6 x 6 x 4 tees in row 2 (tap 1-4) and row 3 (tap 1-6) of Table 1 will corroborate the above conclusion. The hydraulic equation for flow rate (Q) is

$$Q = CA_o \sqrt{\frac{2\Delta P}{\rho}}$$

Q = Flow rate

A_o = Orifice Area

C = Discharge Coefficient

ΔP = Pressure Differential

ρ = Density

From this equation one can see that Q is directly proportional to $\sqrt{\Delta P}$. Table 1 row 2 shows the pressure differential to be highest for the nozzle across the run side meaning more water is flowing in the run side of the nozzle. Table 1 row 3 shows the pressure differential to be highest for the standard tee across the branch side meaning more water is flowing into the branch of the standard tee. Combining the above statements leads to the conclusion that the standard tee has the least restriction to water flowing in the branch side and the nozzle has the most with the T-Drill tee between the two.

In the review of the data for the 4 x 4 x 2 tees in row 6 (tap 5-8) and row 7 (tap 5-10) of Table 1 there appears to be some experimental anomaly associated with the standard tee which can not be explained at this time. But the nozzle and T-Drill data does support the conclusion that the T-Drill tee has less restrictions to flow in the branch side than the nozzle.

V. CONCLUSIONS:

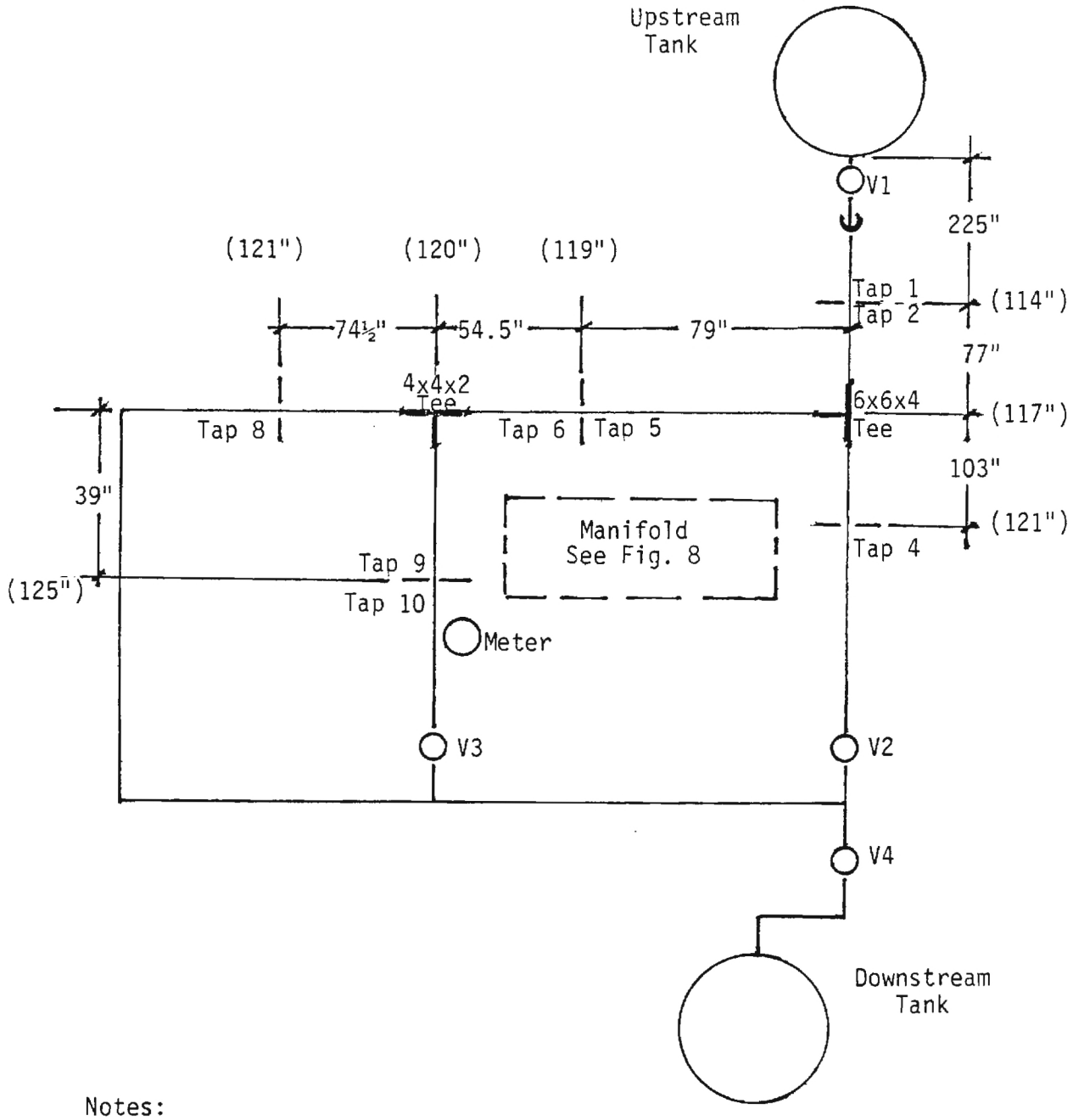
(1) Three different tee type sections were tested: a standard Sch 40 tee, a Sch 40 nozzle type tee, and a Sch 40 T-Drill tee.

(2) Two different size tee type sections were tested: a 6 x 6 x 4 tee and a 4 x 4 x 2 tee.

(3) The tests were run under identical flow condition. One specified for the 6 x 6 x 4 tees and one specified for the 4 x 4 x 2.

(4) The data collected was in the form of pressure differentials.

(5) The data indicated the standard tee to have the best branch flow characteristics. The nozzle had the worst and the T-Drill tee to be between the two with branch flow characteristics closer to the standard tee.



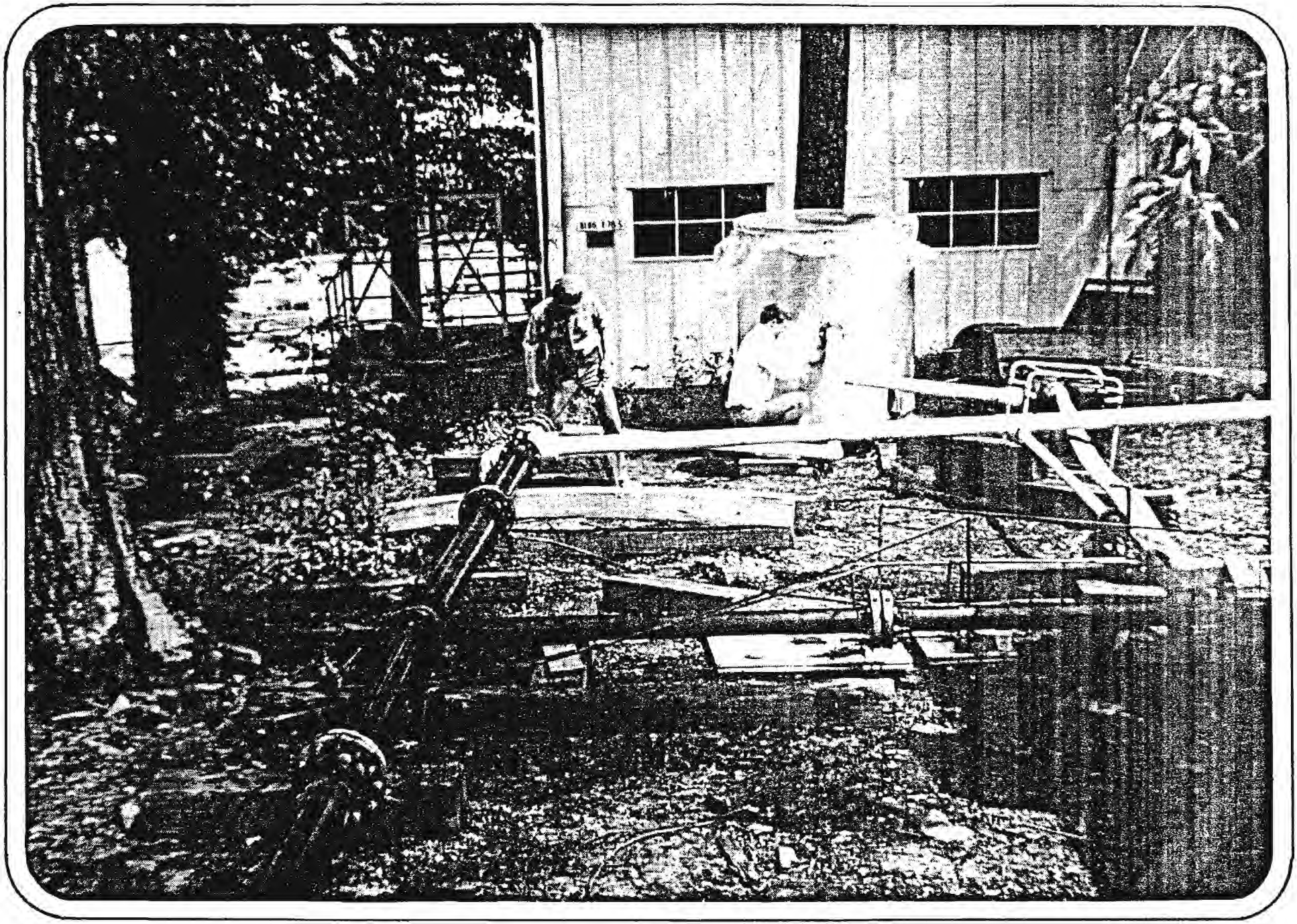
Notes:

(1)

Valves	Type
V1	4" Butterfly
V2	6" Butterfly
V3	2" Ball
V4	6" Globe

(2) Numbers in parenthesis are head differences from water level in the upstream tank.

Figure 1



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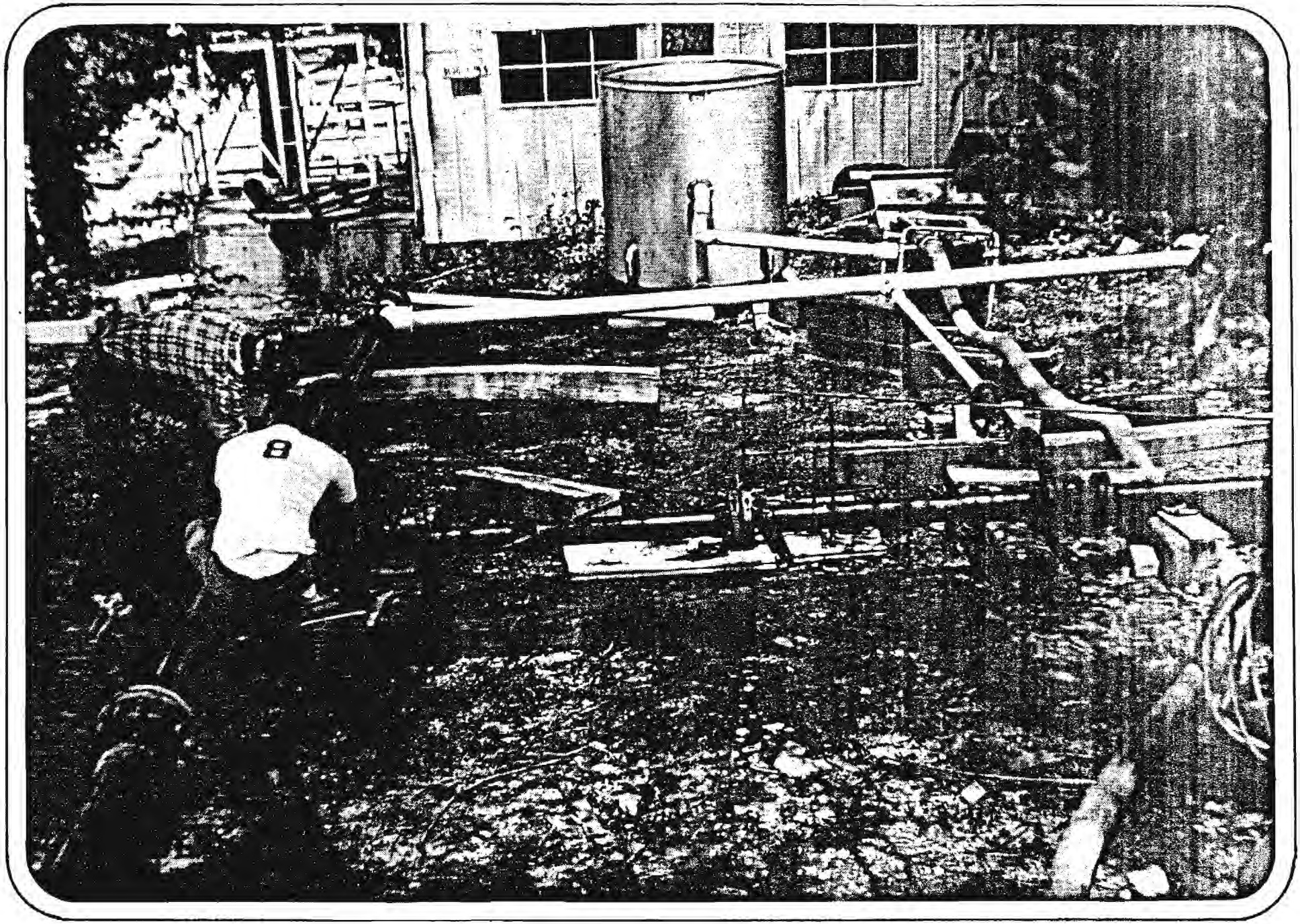

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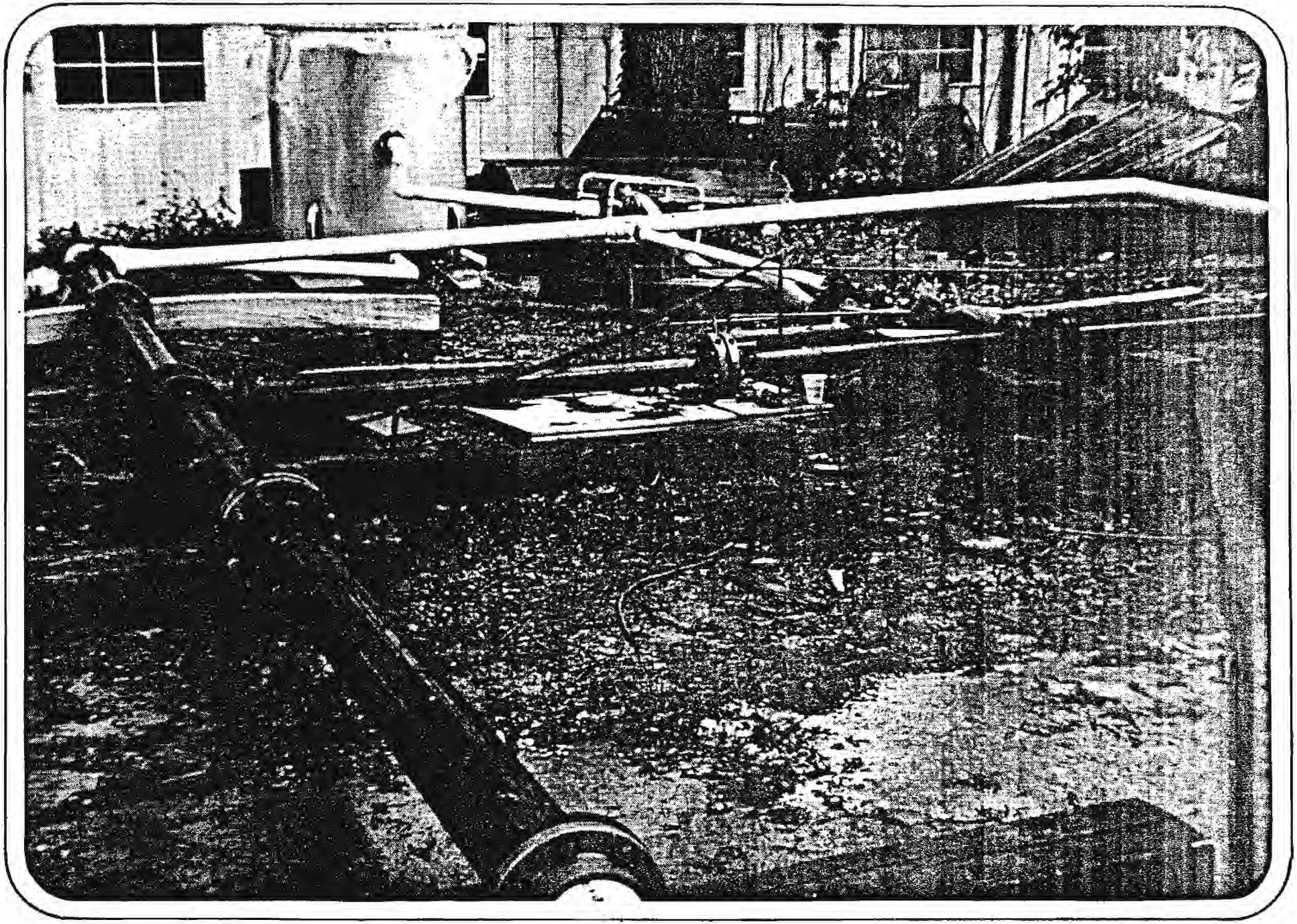


Figure 4

Figure 5

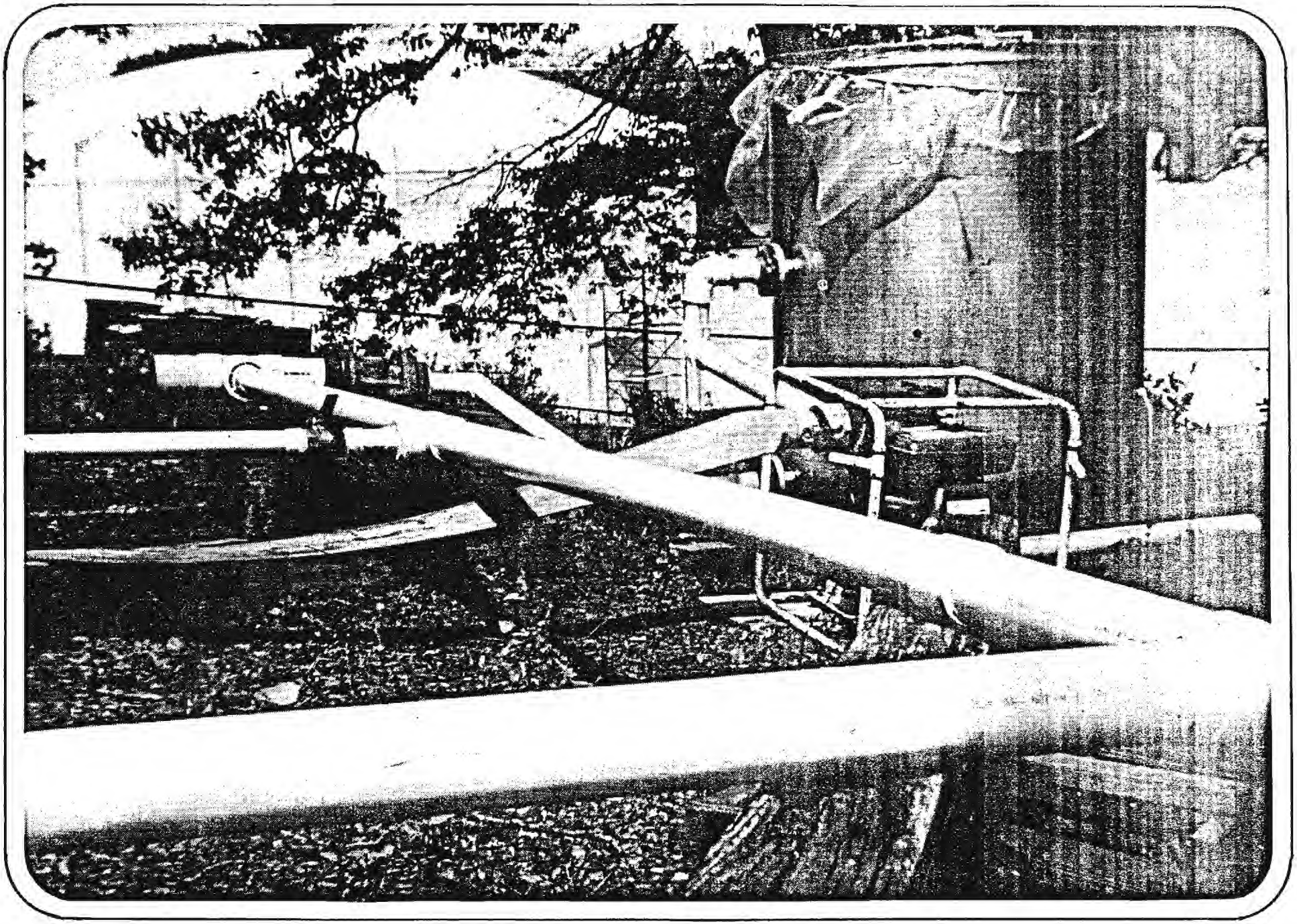
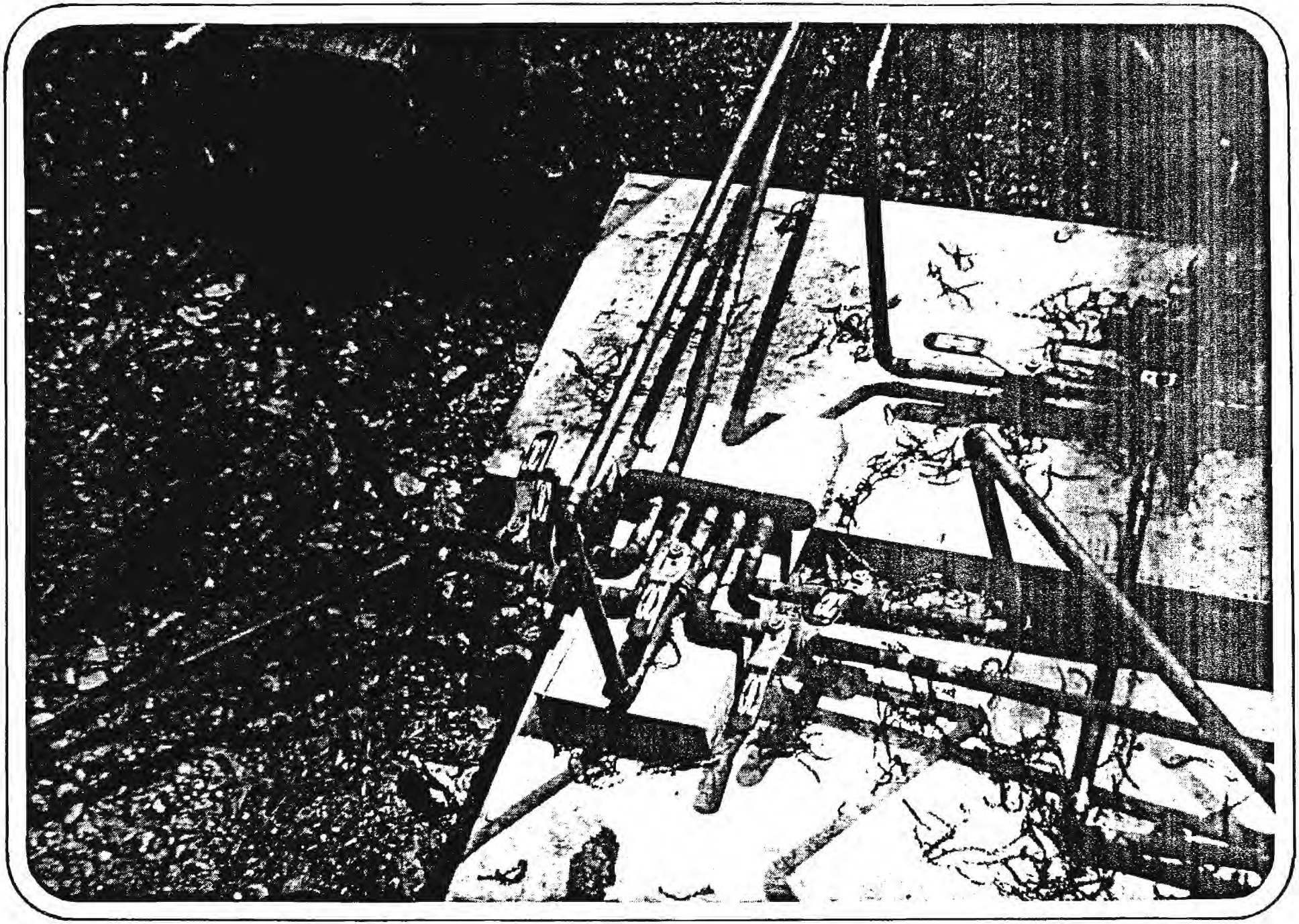


Figure 6

Figure 7



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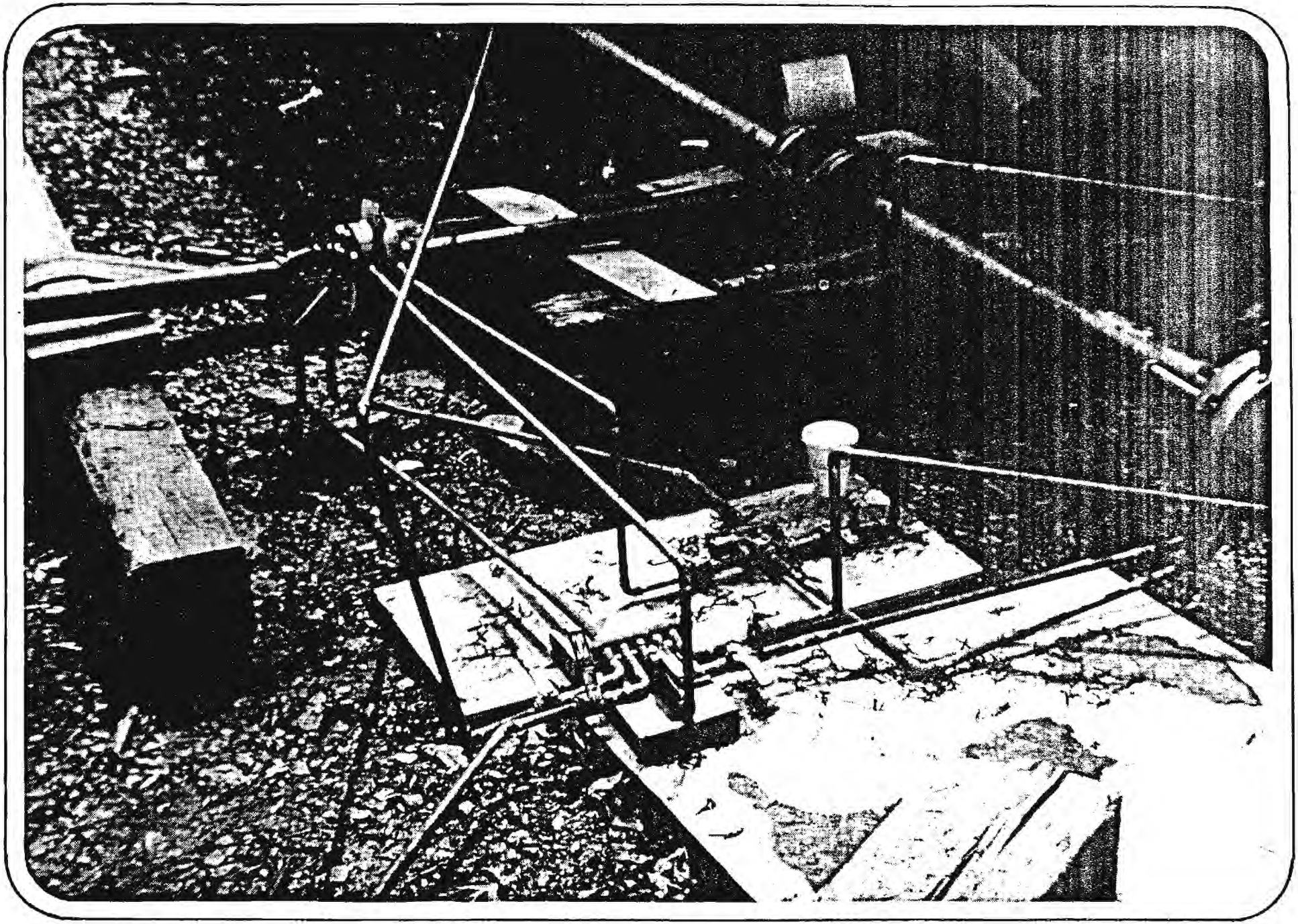

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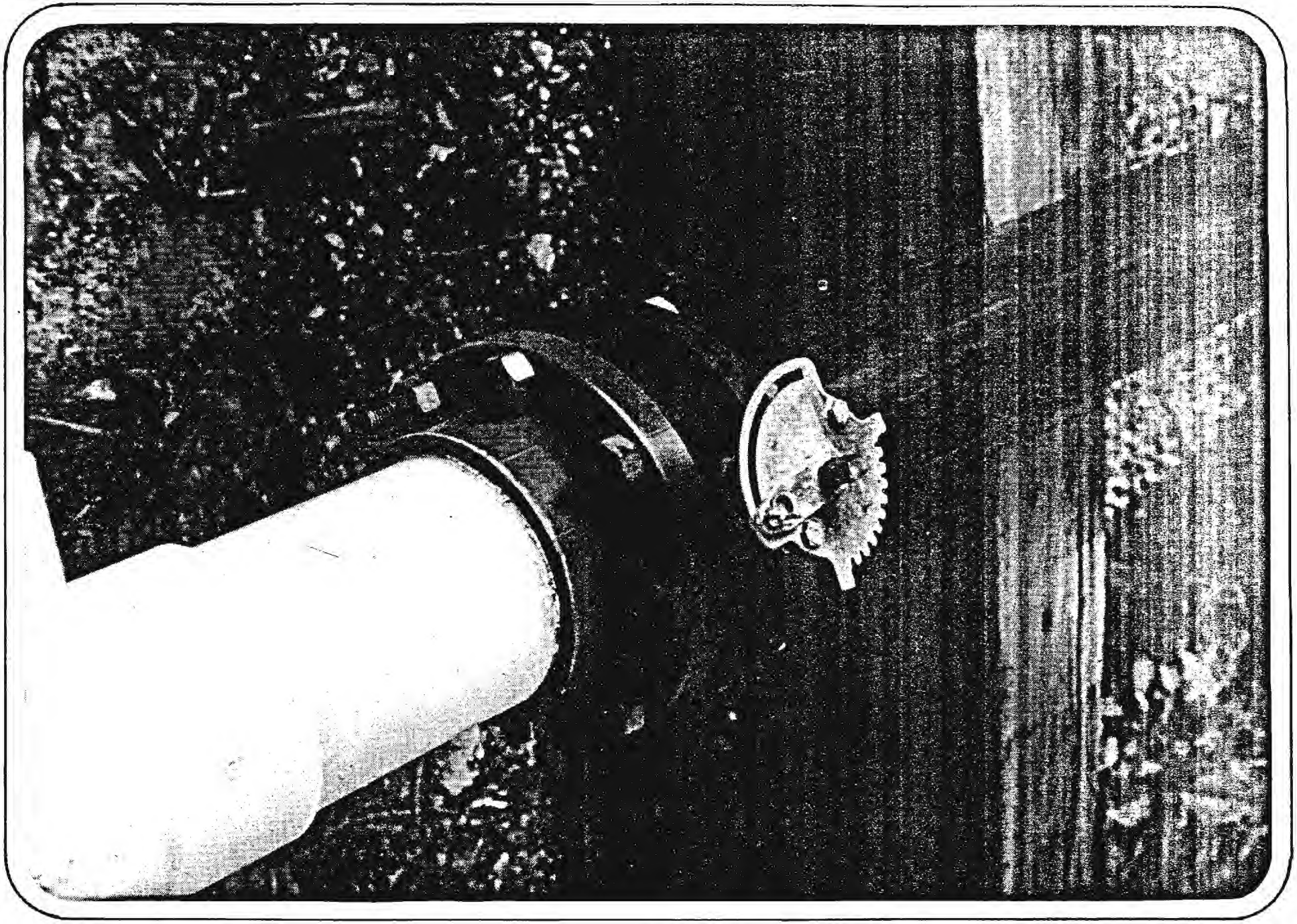
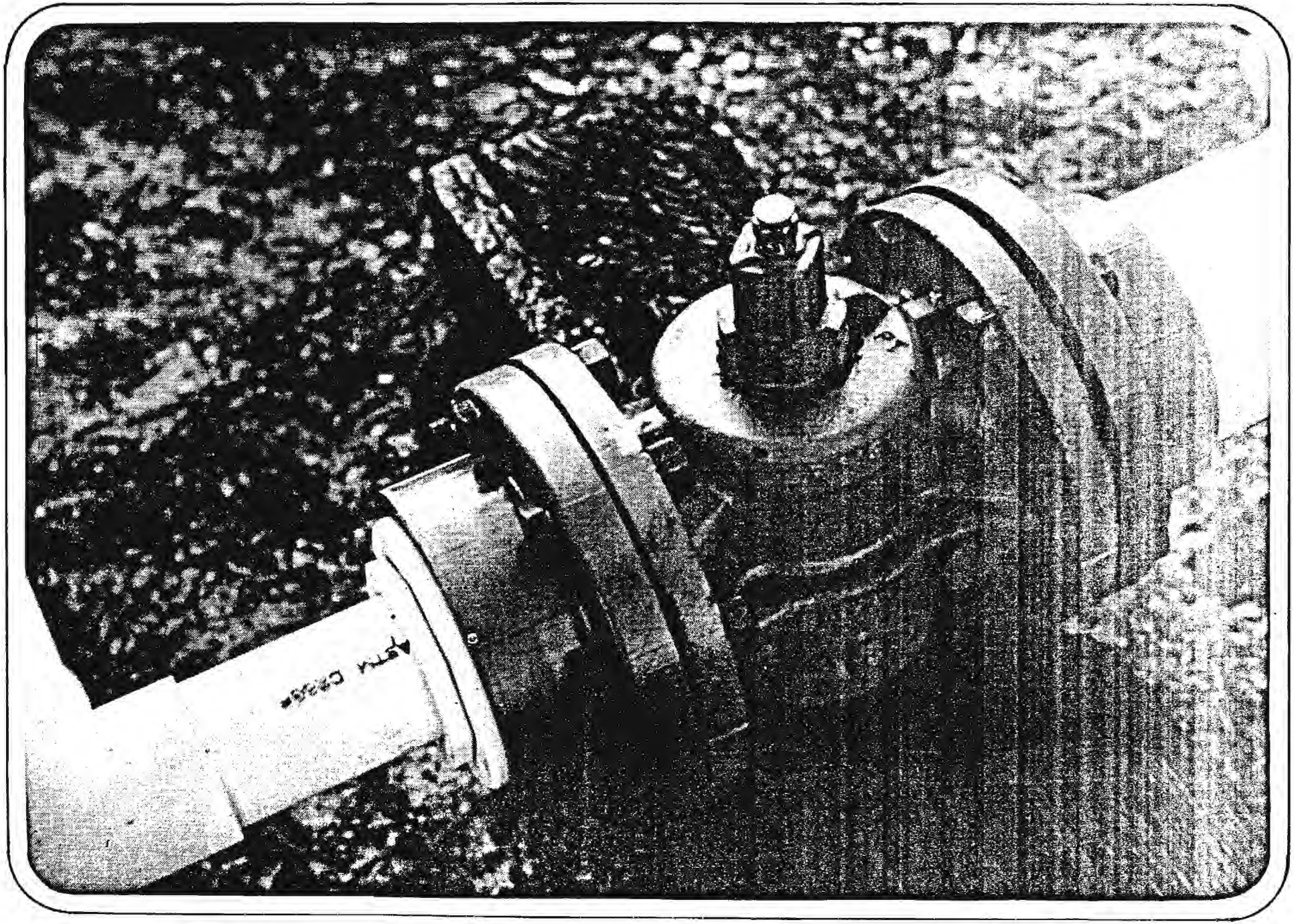


Figure 10



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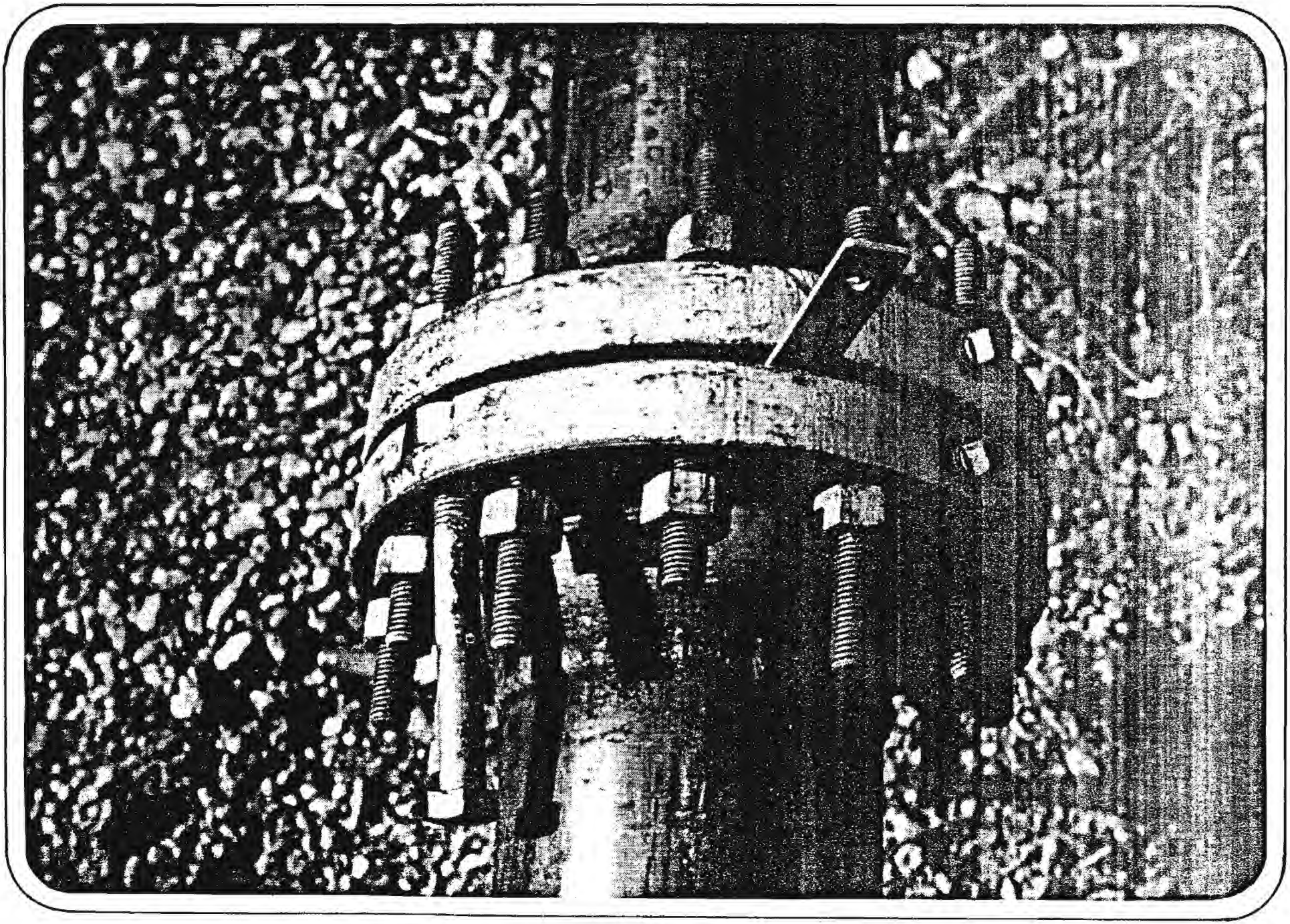

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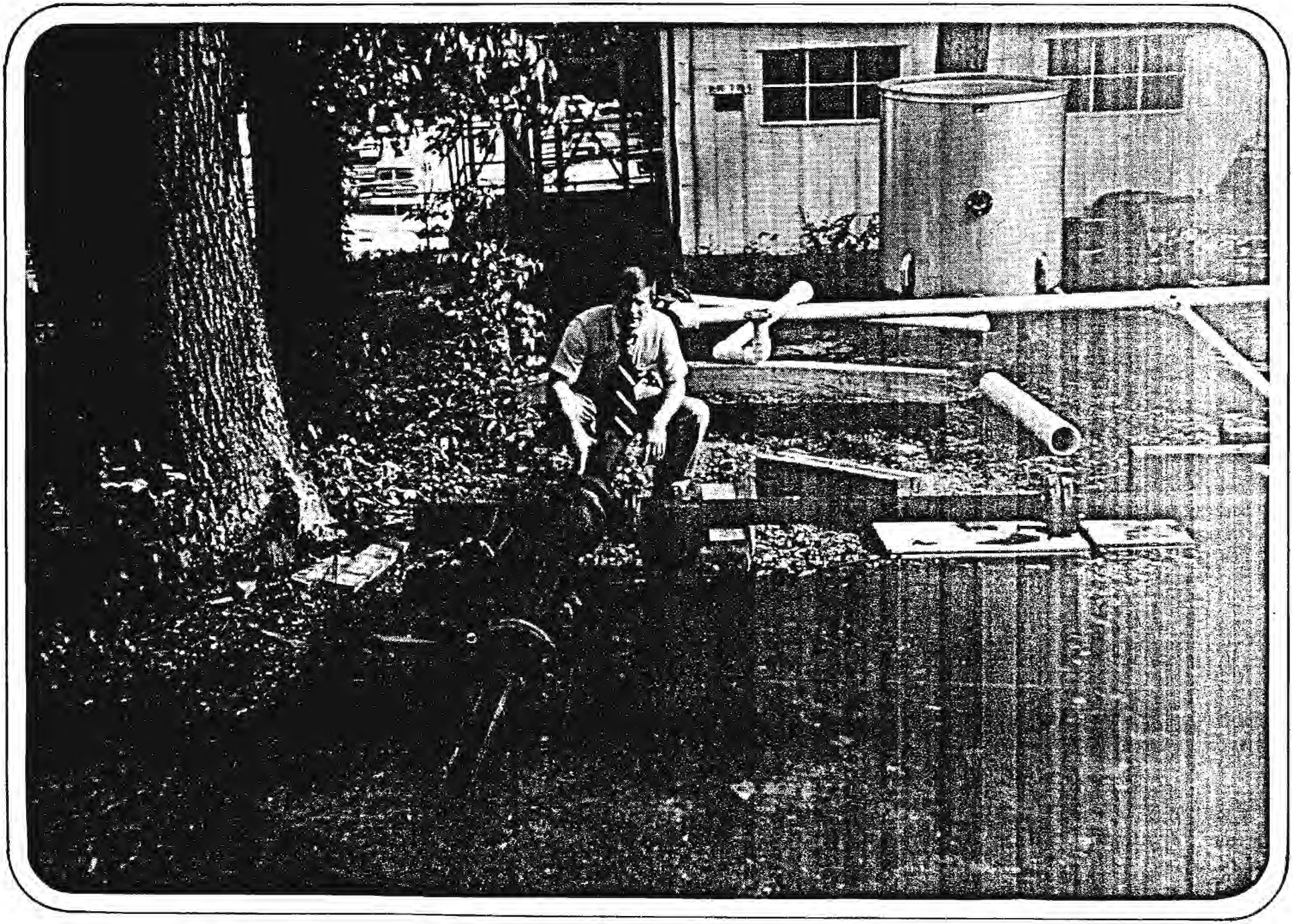

Figure 13

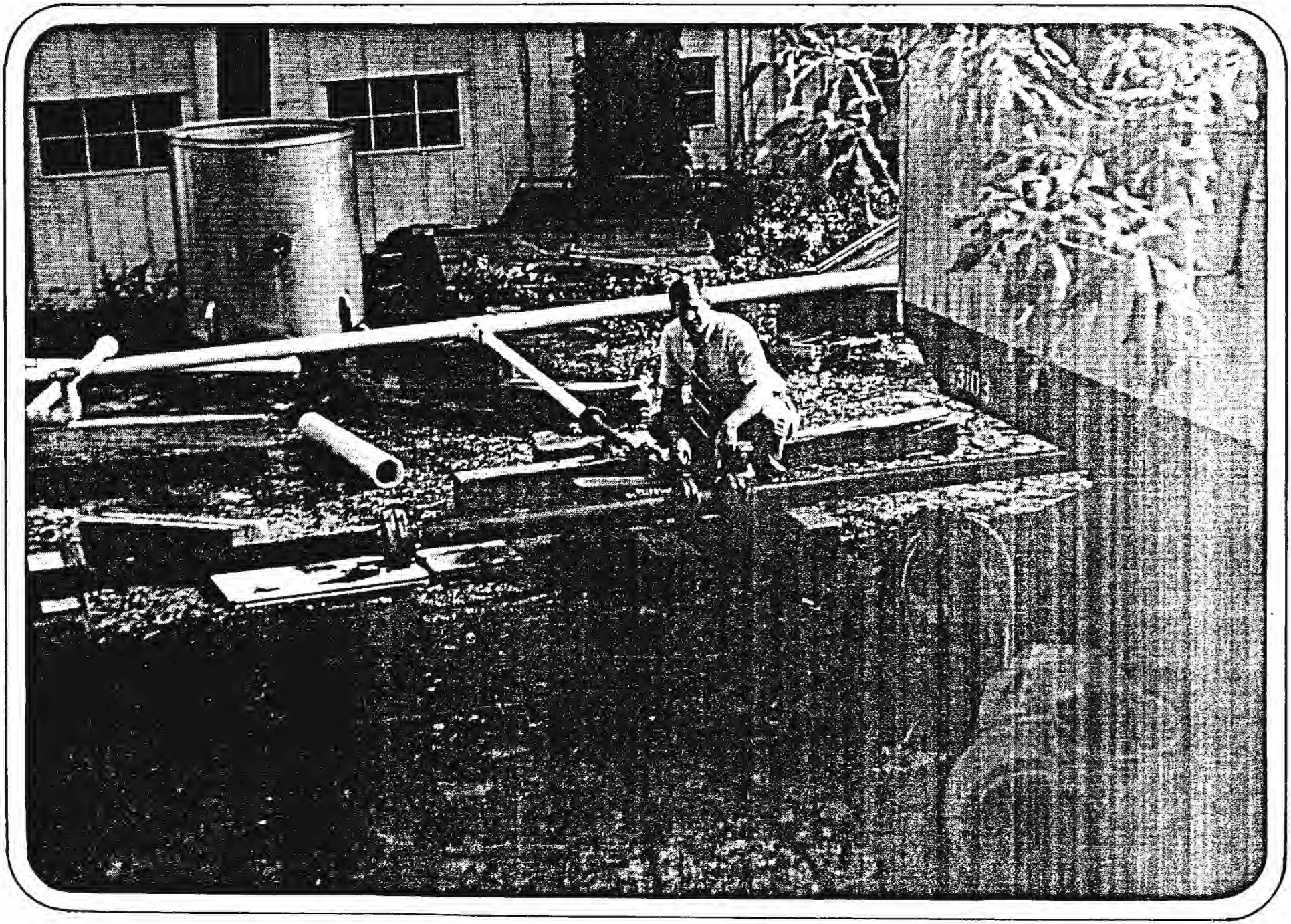

Figure 14

ADDENDUM TO

FLUID FLOW CHARACTERISTICS IN VARIOUS TEE SECTIONS

FOR T-DRILL - ATLANTA

Contract No. A-3712-000

October 22, 1984

R. L. Roglin
Georgia Institute of Technology
Energy and Materials Sciences Laboratory
Atlanta, Georgia 30332

In response to a request from T-Drill an additional review was made of the Pressure Differential Test Data. The purpose of the review was to determine whether a quantitative ranking of the three tee component types could be established. The following conclusions are the result of this additional review:

(1) The test procedure is sound, however in order to determine quantitative rankings for the three tee types with sufficient accuracy the flow rates for the test would have had to be much larger than those available. To achieve this a very large capital investment in pumping equipment and fluid reservoirs would be required. These equipment costs were clearly outside the scope of the limited test program.

(2) To determine the desired information with the specified flow rates the measurement accuracies would have to be on the order of 0.01 inches of water.

(3) At the 95 percent confidence level this test detected no substantial difference between the components on either the branch or run legs.