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MM&T: IMPROVED TUBE STRAIGHTENING.(U)
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DEPARTMENT OF THE ARMY
U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
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DRDAR-LCB-SE 1 September 1982
SUBJECT: Final Technical Report

TO: Commander
U.S. Army Armament Command
ATTN: DRSAR-IRM
Rock Island, Illinois 61299

Project No: 6788045

Project Title: MM&T: Improved Tube Straightening

Project Officer: C. H. LaRoss

Statement of the Problem: Past MM&T developments have been instrumental in reducing the size of the tube forging. Because of this reduction, stock distribution, a non-machining process, has become a more critical operation in that closer requirements are held on the forging straightness. The press previously considered acceptably accurate was now required to be updated or improved to provide the operator with the capability of monitoring and controlling the press operation to these more precise requirements.

Background and Introduction: The method for measuring tube straightness, viz. stock distribution, has improved over the past years to provide press operators with accurate dimensional variations in total indicator runout (TIR). This quantity represents the eccentricity of the forged material around the true centerline of rotation. From the simple but effective steel pole (Photo 5 Item 16) and dial indicator (Photo 5 Item 20) to the more sophisticated vidigage (Photo 2 Item 11) and electronic "mouse" (Photo 2 Item 12) advances have been made in controlling varying wall thicknesses. Sensing systems, then, have improved but the application of this data into press ram displacement remained a coarse technique. A steel pointer (Photo 1 Item 4) mounted to the ram or moving part is positioned in loose proximity to a steel scale (Photo 1 Item 3) attached to the frame or stationary member. As the ram is lowered exerting downward pressure, bending the gun tube, the press operator follows the pointer as it travels along the scale. The operator then reads the distance traveled when the ram is stopped at a point estimated to produce the desired bend necessary for removal of the eccentricity. The steel scale, which is used for monitoring gun tube deflection, is divided into 1/4 inch increments. The operator records the amount of ram travel

This project was accomplished as part of the US Army Manufacturing Technology program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques and equipment for use in production of Army materiel.

by marking the scale with a piece of chalk at the point of the ram's lowest decent. This chalk mark (Photo 1, Item 5) then becomes the point of reference for subsequent pressing required until the gun tube has been pressed or straightened within dimensional tolerances. Although this process appears to have been effective over many years, it has been a process that is not easily learned by new personnel. The old method of scale, pointer and chalk is not one which inspires confidence in controlling and monitoring the distance the ram travels as a gun tube is pressed.

A monitoring system that utilizes a wide chalk mark scratched across a steel scale to indicate ram travel is indicative of the need for a reliable system to monitor tube bend. A reliable process that could be accurately controlled and easily learned by prospective press operators was needed.

Approach to the Problem: Electronic equipment for measuring machine tool position provides an accurate and readily adaptable means of monitoring hydraulic press ram movement. Initially, a scan of DIPEC was made to determine whether suitable equipment capable of this function was available for adaptation to the project effort. This investigation was negative. A survey was then made to solicitate interested suppliers of the type equipment required to provide improvement for gun tube straightening. A supplier, Teledyne Gurley, Troy, New York responded to a request for technical assistance in selecting the type equipment required to accomplish the desired result. The equipment would have to be capable of sustained production application and be resistant to press vibration as well as overhead crane noise and vibration. Additionally the equipment had to be easily adaptable to press mounting and be resistant to shop dust and contaminants such as hydraulic oil.

After examination of the hydraulic press on which the equipment would be installed, it was decided that a Teledyne Gurley Pathfinder 5 Model 8780 digital readout system (Photo 1, Item 1) could be used. The system is a single axis solid state microprocessor with high noise immunity. The equipment includes a floating zero, absolute zero, inch/millimeter conversion feature, preset keyboard entry and power interruption warning indicator. The system is adaptable to all hydraulic presses in general, with no requirement for special attachments or features.

The advantages of adapting this type of equipment to hydraulic pressing of gun tubes are:

a. Accuracy & repeatability.

b. Easy reading and recording.

c. Reduced pressing time.

d. Minimal training required.

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Discussion of Results: The delivery of the digital readout equipment for improved gun tube straightening was made in December 1979 under contract DAAA22-79-M-5668. The necessary hardware was fabricated by which the equipment could be mounted to a production line press on which it would be installed. On February 1, 1980 the unit was mechanically installed on the press and on February 4, 1980 a temporary electrical attachment was made to expedite the testing and evaluation phase of the project. The press selected was a 1000 ton Lombard WV10120 located in Building 135, B Bay, Sections 17 and 18. On February 4, 1980 the day shift operator was instructed on how to use the digital equipment. On March 5, 1980 the fifty-third (53) gun tube was pressed using the digital system. Following are the results of the test and evaluation phase of gun tube pressing using the digital readout system.

a. Accuracy and Repeatability: The digital system, as purchased, is accurate to ± .00025 inches per foot. The required accuracy for pressing gun tubes does not require this fine a reading but the equipment is standard to this accuracy. To make the digital display more readable and compatible to the accuracy required for pressing gun tubes, the last two (2) digits (thousandths and ten thousandths inches) were masked off so reading the display would be less confusing to the operator. The need for press ram travel accuracy beyond two (2) digits or hundreths of an inch is unnecessary. The repeatability of the digital equipment is .0005 inches and is the standard resolution on equipment as purchased. The accuracies are standard and add no extra costs to the equipment but they give the press operator an added confidence in that he can now "see" very clearly the exact location of the ram as the gun tube is being pressed. With the accuracy and repeatability of digital equipment, the operator now has the control necessary for operator efficiency.

b. Easy Read and Recorded: The numerals, as they are displayed on the digital readout, are six tenths (.6) inches in height, making them easy to see. As the operator presses or straightens the gun tube he watches the digital display until the estimated deflection appears on the number display. The operator then releases the pressure on the ram which returns to its up position. The tube is then free to rotate to determine the amount of permanent deformation which effectively holds the tube in a straight condition. Straightness or reduced eccentricity is determined by a dial indicator sweep from minimum reading to maximum reading as the tube is rotated. At each reading, a new estimate is made of the deflection required to deform the bent tube into a straight condition. This process is repeated as many times as necessary using the last recorded number as a reference point from which additional deflection is attempted. By comparison with the current method the operator is watching a crude pointer as it travels along a steel scale and when the ram reaches the point he has preselected he stops the downward travel of the ram, scratches a chalk

mark across the scale, raises the ram and indicates the result. The chalk mark made by the operator is approximately 1/8 inch wide. This is his reference point for subsequent bends and unquestionably is not conducive to accuracy and repeatability to say nothing of operator confidence.

c. Reduced Pressing Time: From 4 February 1980 to 5 March 1980 a total of fifty-three (53) gun tubes were pressed using the digital readout system. To arrive at a pressing time per tube using the digital equipment, an average value was taken for all fifty-three gun tubes. This value, although not a per unit time study, is a reasonable evaluation of the effectiveness of the digital readout equipment as it was applied in the pressing and straightening of the fifty-three gun tubes. At the conclusion of the test and evaluation period of this project effort, data showed that the introduction of digital readout equipment had reduced pressing time by a minimum of 50 minutes per gun tube. It is difficult to arrive at a time studied pressing time that would be applicable to all gun tubes of the same caliber and condition. Each gun tube is unlike the next in the amount and position of bend, therefore, each tube requires individual analysis and individual pressing procedure. For the experienced press operator the digital readout system will increase efficiency. For the inexperienced press operator the system will actually decrease the experience required to become proficient. This is accomplished by removing from the operation the element of interpretation of an inadequate reading system and replacing it with the latest in the state of the art in linear measurement. The introduction of digital readout equipment to gun tube pressing operations has given the press operator confidence and assurance that he now has control over the pressing operations that he did not previously have.

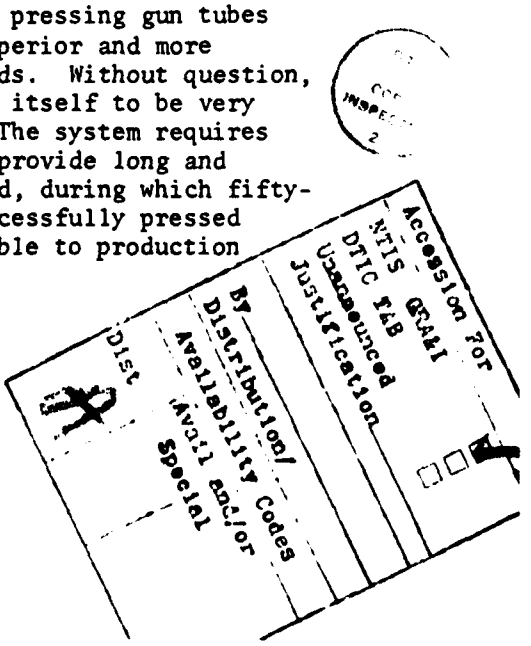
d. Minimal Training Required: The learning period or training process for using digital readout equipment is simple and easily accomplished. Basically, all the operator is doing is reading a number, recording that number and repeating this process for "X" number of times per gun tube until the gun tube is pressed to dimensional requirements. See Appendix I for operational sequence for gun tube pressing using digital readout equipment. The system has what is referred to as a "floating zero" which allows the press operator to set a zero point at any desired location along the scale. In this first instance of digital readout for gun tube pressing, the operator was very receptive in accepting the new process and required approximately one (1) hour of instruction. A reasonable time estimate for new personnel to learn how to use the digital system for pressing gun tubes would be four to six hours. A minimum of skill is required to use this type of equipment for gun tube pressing but the proficiency gained in its use over present methods using scale, pointer and chalk is far superior and certainly without question more reliable.

Press Blocking: A secondary effort of this project was to improve pressing capability involving the solid blocks used to establish the span of the press's action, i.e., the overall length of the portion of tube to be bent. (This varies depending on the amount and position of the initial TIR.)

The steel pads (Photo 4 Item 10) and blocks that the gun tube rests on provide support for the gun tube while pressing. The blocks take the full load exerted by the ram and are made from alloy steel heat treated to withstand the pressures they are exposed to. They are designed to prevent chipping off or fracturing on the inside edge or corner where the gun tube comes in contact while pressing. A new design was conceived to allow greater flexibility in pressing gun tubes especially where short bends are necessary. This occurs when the degree of eccentricity requires close positioning of the support blocks in order to remove the eccentricity. The new design enables the operator to achieve closer bends that were previously not possible. This was made possible by tapering the inside edge of the support blocks. This taper will allow the gun tube to rest on the block at a position approximately five (5) inches in from the inside edge. This will in effect give the press operator an additional ten (10) inches of span between the support blocks than is available with the current designs. The blocks were designed to adapt to the press with no modification to the press required.

Conclusions and Recommendations: The pressing or straightening of gun tubes is a difficult and tedious operation. There are no set guidelines that can be applied to assist the operator in pressing a gun tube. It is impossible to predict how much each individual gun tube will have to be pressed in order to straighten it to acceptable limits. Due to these conditions it introduces a measure of tension or strain on the operator. Any input that would give greater control which would induce more operator confidence would be of benefit to both operator efficiency and process improvement.

The application of digital readout equipment for pressing gun tubes has proved the feasibility of the system as a superior and more accurate and reliable process than current methods. Without question, once learned and understood, the system will show itself to be very basic, simple to operate and easily adaptable. The system requires little care and with proper attention it should provide long and reliable service. The test and evaluation period, during which fifty-three (53) gun tubes of different sizes were successfully pressed without difficulty, has proven the system adaptable to production application.



The system has been used consistently on the first shift, five days a week for the past three months since testing and evaluation was concluded. The digital readout equipment is adaptable to all hydraulic presses currently in use at Watervliet Arsenal. The system is both economical and reliable requiring minimal installation costs (Photos 1 and 3) and will reduce pressing costs 28% or $36.58 per tube (FY 80 $).

It is recommended that all hydraulic presses used in straightening gun tubes be modified to include digital readout equipment. The equipment's cost could be recovered in approximately two weeks on a one shift basis for each unit purchased.

It is further recommended that since the new block design provides a span reduction capability of approximately 20%, it would be advantageous to expand this technique. However, since there is no monetary gain, this change can be accomplished during maintenance on an as required basis.

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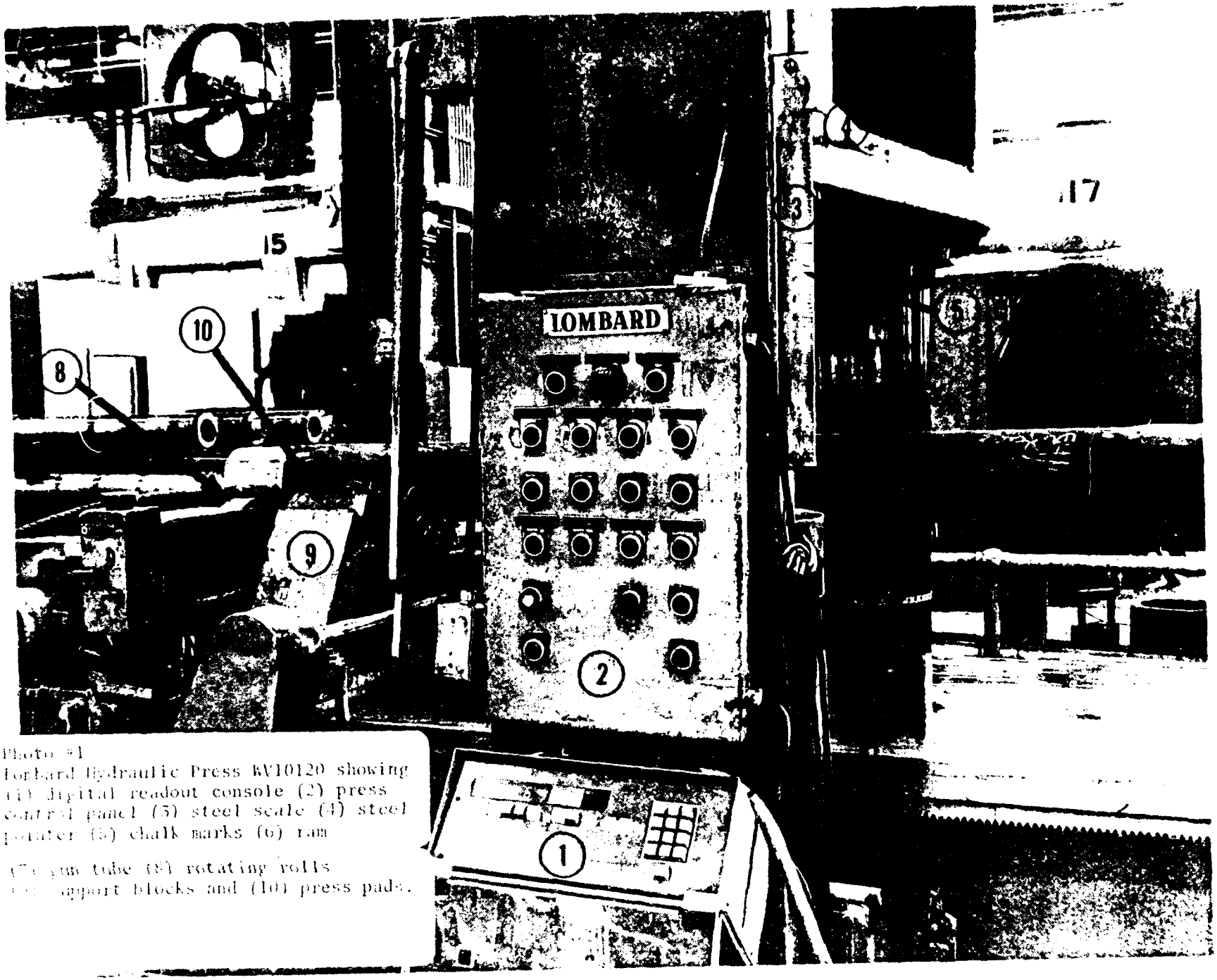

Photo #1
Lombard Hydraulic Press MV10120 showing (1) digital readout console (2) press control panel (3) steel scale (4) steel pointer (5) chalk marks (6) ram (7) gun tube (8) rotating rolls (9) support blocks and (10) press pads.

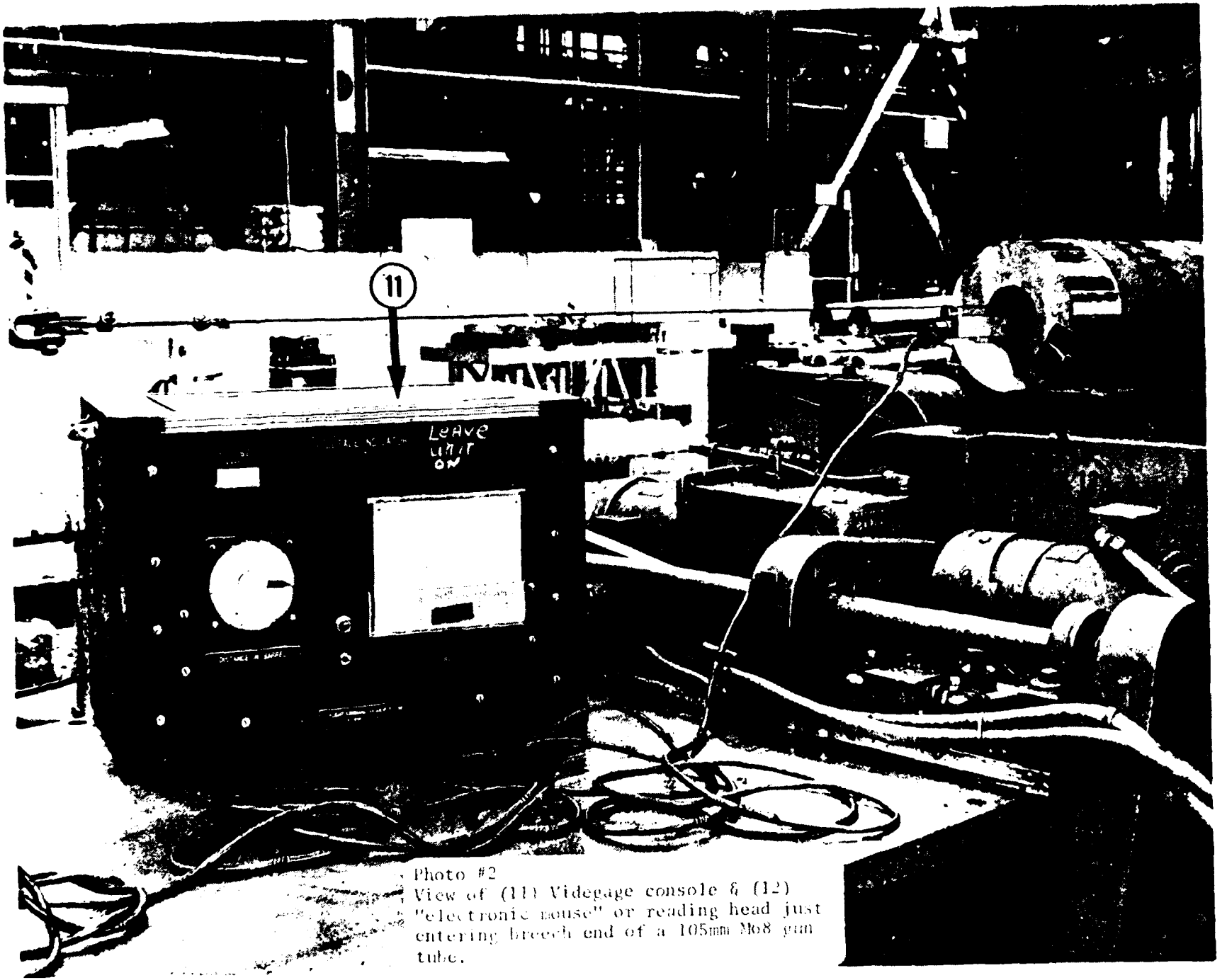

Photo #2
View of (11) Videgage console & (12) "electronic mouse" or reading head just entering breech end of a 105mm M68 gun tube.

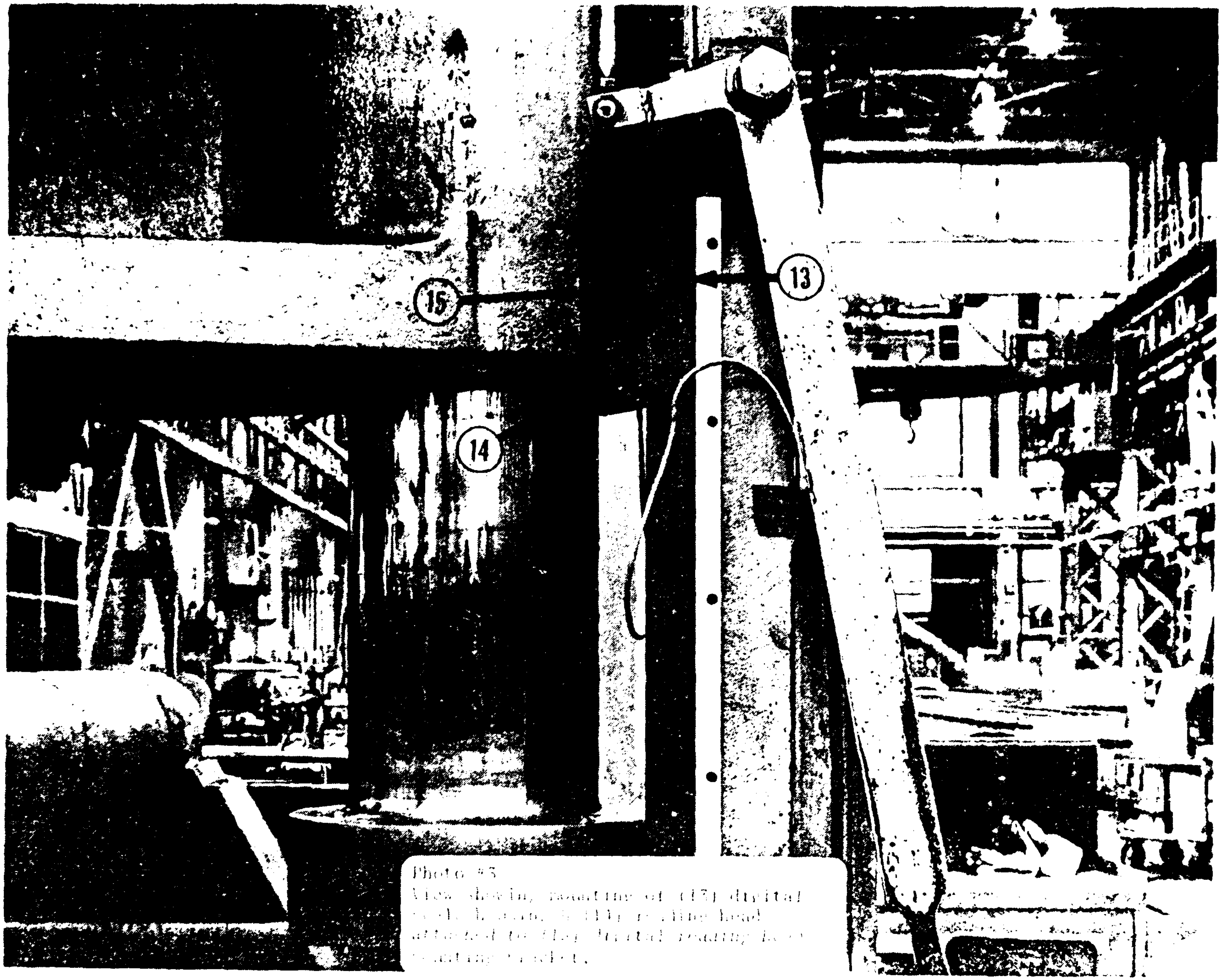

Photo #5
View showing mounting of (13) digital [illegible] & (14) reading head attached to [illegible] digital reading [illegible] mounting bracket.

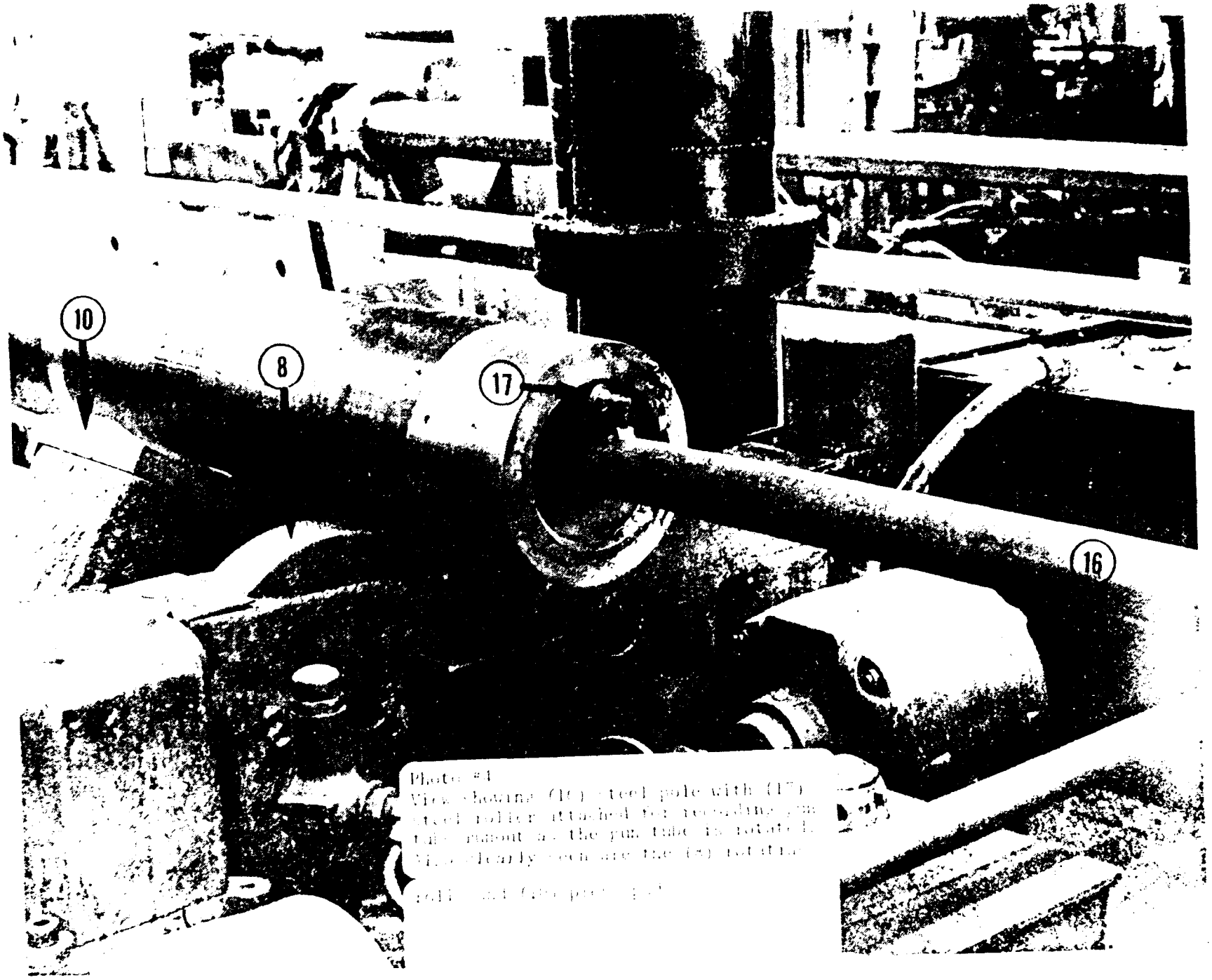

Photo #1
View showing (10) steel pole with (17) steel roller attached to secondary gun tube mount as the gun tube is rotated [illegible] clearly seen are the (8) rotating

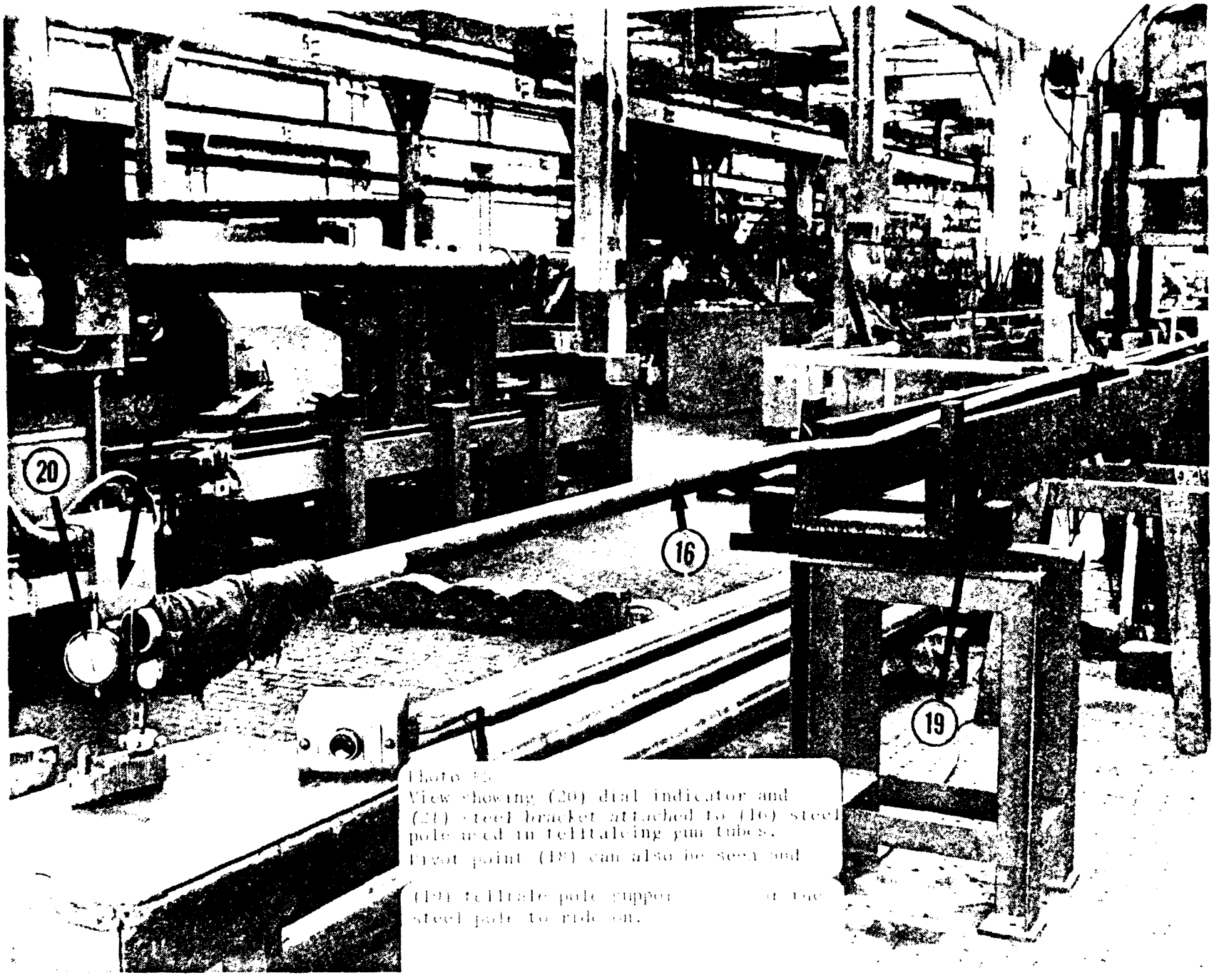

Photo #3
View showing (20) dial indicator and (21) steel bracket attached to (16) steel pole used in telltaleing gun tubes. Pivot point (18) can also be seen and (19) telltale pole support [illegible] steel pole to ride on.

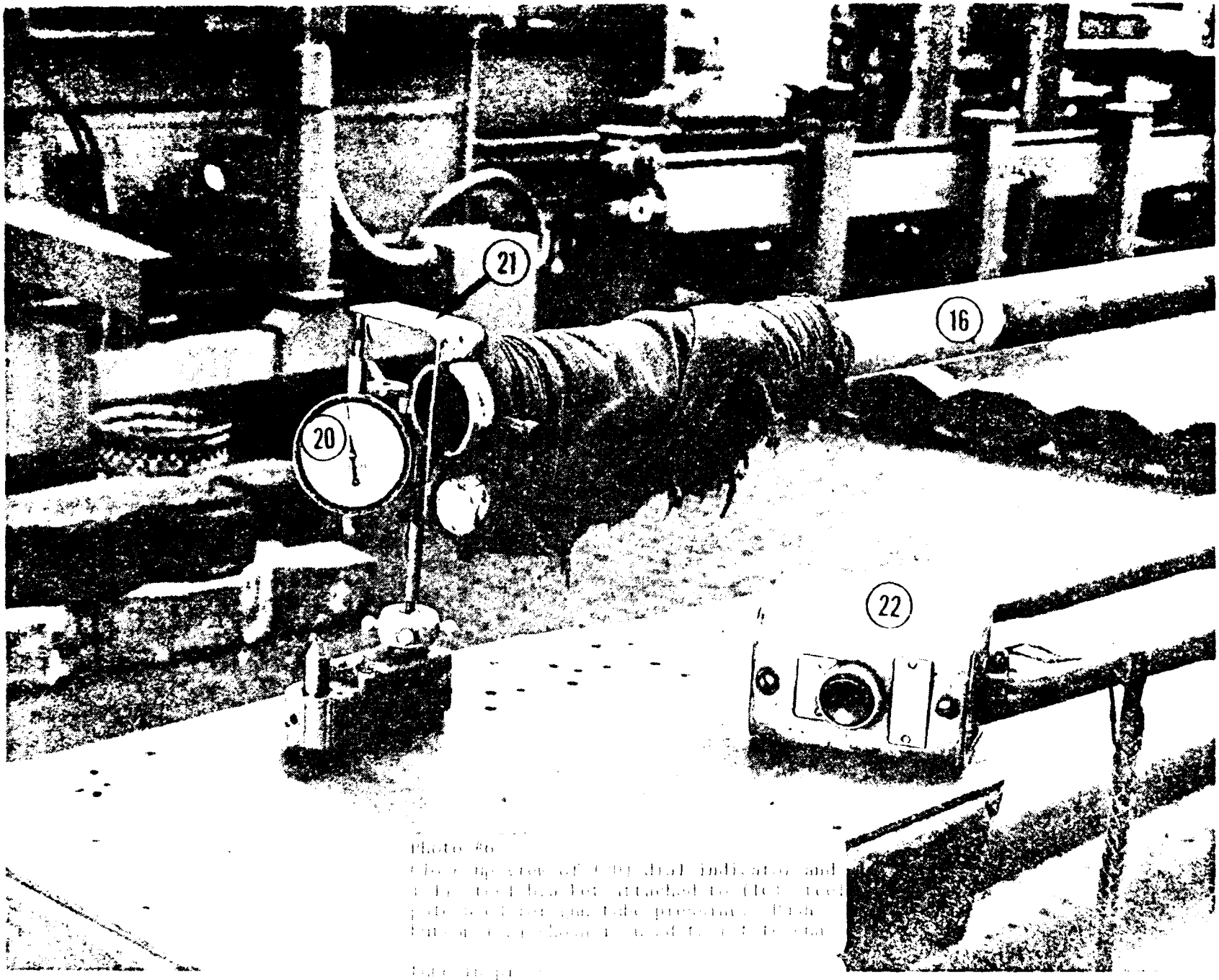

Photo #6

PHOTO LEGEND

Photo #	Item	Description
1	1	Digital Readout Console
1	2	Press Control Panel
1	3	Steel Scale
1	4	Steel Pointer
1	5	Chalk Marks
1	6	Press Ram
1	7	Gun Tube
1	8	Rotating Rolls
1	9	Support Blocks
1	10	Press Pads
2	11	Vidigage Console
2	12	Electronic "Mouse"
3	13	Digital Scale Housing
3	14	Digital Reading Head
3	15	Bracket, Digital Reading Head
4, 5, 6	16	Steel Telltale Pole
4	17	Steel Roller
5	18	Pivot Point
5	19	Telltale Pole Support Base
5, 6	20	Dial Indicator
5, 6	21	Steel Bracket
6	22	Push Button

APPENDIX I

Digital Readout System for Gun Tube Pressing

Operational Sequence

1. Load gun tube in press.
2. Check tube eccentricity at designated points and mark.
3. Position press over first point to press. Breech end first.
4. Position support blocks in proper position.
5. Turn power switch on digital equipment to ON.
6. Lower ram until just touching tube and depress zero reset button on digital console.
7. Continue lowering ram until selected distance to press is reached and record number on digital display.
8. Release ram and raise off gun tube.
9. Raise turning rolls and check for eccentricity.
10. Repeat 6 thru 9 until tube is straightened to acceptable limits using previous recorded number as reference point.
11. Unload gun tube from press.


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