MAKE-UP OF TUBING

WD Stringfellow and Trevor West
Weatherford U. S. Inc.

ABSTRACT

Tubing make-up involves the joining of two threaded joints of tubing to form a leak tight structural connection. This activity is recognized as being an important part of the effort required to produce hydrocarbons.

This paper seeks to identify factors that can affect the success of the make-up process. Having identified these factors, a brief review of their impact on connection make-up is presented. With this understanding, an effective running procedure can be developed.

Considered are connection design, vertical alignment, connection cleanliness, the power tong, connection monitoring, the thread compound and weight transfer.

INTRODUCTION

The handling and make-up of tubing into a string has been recognized as an important part of the overall process involved in the recovery of hydrocarbons.

In service, the tubing string consists of a number of individual lengths of tubing made-up (joined together) through the use of threaded connections to form a pressure vessel with extremely large length to diameter ratio. This tubing string is required to perform as any pressure vessel, that is, remain leak free under a combination of internal and external loading conditions.

This paper seeks to present a systematic approach toward the make-up of tubing that analyzes factors that influence connection sealibility. The results of the analyses are used to develop a procedure for make-up that is geared for success.

MAKE-UP PARAMETERS

The following is a listing of the make-up parameters that will be discussed in this presentation:

* Connection Design
* Connection Alignment
* Connection Cleanliness
* The power tong
* Connection Monitoring
* Thread Compound
* Weight Transfer

CONNECTION DESIGN

Consideration of the type, design and manufacture of the connection is essential to developing a running procedure. Elements to be considered include the sealing mechanisms, the material grade and the anti- galling coating or plating used.

Oil country tubulars utilize three basic seal mechanisms to obtain leak tight connections. These are interference fit tapered thread, elastomeric seals and metal to metal (flank and shoulder) seals. These basic design elements are used independantly or in various combinations. The make-up characteristics of each must be considered in developing a make-up procedure. See FIGURE 1.

Interference fit tapered threaded connections, such as API 8 round, establishes a leak tight connection by developing bearing pressure on the thread surfaces and sealing the designed in leak path with a thread compound. Required is application of torque[1] and/or torque and turns[2] and the use of API Modified Thread Compound[3], or equal. Published torque values are normally based on the use of API Modified compound and should be adjusted, as needed, if a different compound is used.

Elastomeric sealed connections, such as the API seal ring coupling, adds an elastomeric seal ring to the connection. The use of a seal ring often affects the make-up torque. For example, the make up torque required for the API seal ring coupling is approximately 70 % of the torque required for the standard API 8rnd[4]. See FIGURE 2.

Metal to metal sealed connections, such as the API Extreme Line Connection, require that bearing pressure be developed between the sealing surfaces. In connections with cylindrical flank seals, this pressure is developed by design and manufacture and not controllable during make-up. For tapered flank seals and shoulder seals, the application of a controlled torque is required.

Most premium connections have multiple seals. The requirement of each sealing element must be considered. FIGURE 3 is a composite of typical torque - time curves for various connections to illustrate acceptable make-up parameters.

Material grade is important because some grades, generally the softer materials, have a greater tendency towards galling, thus requiring special handling. Corrosion Resistant Alloys (CRA's) always tend to gall.

The anti-galling coating, or plating, is essential to avoid galling during the make-up / break-out procedure and, in some instances, for improved sealability. The coating, or plating, is known to affect the make-up parameters. For example, API Buttress connections that have been zinc plated require approximately 125 % of standard torque for make-up.

CONNECTION ALIGNMENT

Recent tests reported by Southwest Research Institute[5] indicate that the vertical alignment of some connections is critical if galling is to be avoided. The testing of premium connections indicate that vertical misalignments as small as 2.0 inches, over the full joint length, is sufficient to result in connection thread damage. Recommendations resultant from this test program include the use of an adjustable alignment guide to maintain precise vertical alignment on premium connections.

CONNECTION CLEANLINESS

A common cause of leaking connections is dirty threads. The contamination prevents the formation of the required bearing pressure on the thread flanks, interferes with metal to metal seals and contributes to galling.

Cleaning of threaded connections prior to use is normally required. The cleaning procedure, and agent, used are important. Power cleaning with nylon bristle brushes is acceptable for most connections.

As a cautionary note, the use of diesel oil, and / or wire bristle brushes, is not recommended. Diesel oil dries leaving a film that can interfere with proper make-up. Wire bristle brushes can damage threads and / or transfer metal particles to CRA material promoting corrosion.

THE POWER TONG

The selection of the power tong to be used in make-up / break-out is important for several reasons. Areas that should be considered include:

Gripping Mechanism. Most power tongs employ a "penetration" type gripping system. That is the heads, or jaws, contain hardened steel inserts with sharp points to penetrate the tube body allowing transmittal of torque. The amount of penetration varies with gripping system design.

The optimum penetrating gripping system will allow the jaws to engage with radial (as opposed to a combined radial- rotational) motion prior to application of torque and limit the maximum loading applied to the tubing.

Rotational Speed. Tests have shown that excessive rotational make-up speed is detrimental to the connection and may result in over torquing. Overtorquing occurs because the rate of application of torque becomes too high to be consistently controlled. The maximum make-up speed for tubing should not exceed 15 RPM. This should be reduced even further for most premium connections and materials.

Power tongs are available with the capability for make-up at speeds as low as 0.5 RPM. Reduction of the make-up speed improves the repeat-ability and control of applied torque and reduces the tendency to gall. These tongs should be used in critical applications.

Shear / Bending Moments. The typical power tong is tied (snubbed) off to a static point on the rig to react the make-up forces. This snubbing introduces shear and bending moments into the tubing at the top of the spider. These forces can be detrimental to tubing. See FIGURE 4.

The use of a properly designed tong complete with integral back-up device will eliminate the need for a snub line and hence these undesireable forces. This type of tong is recommended for use with internally coated and flexible tubing. See FIGURE 5.

CONNECTION MONITORING

In critical applications, the use of connection monitoring techniques is recommended. These techniques use a computor to monitor and record the torque-turns-time applied to each connection during make-up. The data developed can be used to determine whether the proper controls have been applied to the connection prior to running it into the well. See FIGURE 6.

This type of system can provide:

* Direct correlation with the applied torque.
* Records of calibration testing to insure accuracy.
* A permanent record of each connection make-up.
* High response time to ensure that "spikes" of torque are not missed.
* Automatic control of the applied torque.

The use of hydraulic pressure gages to monitor torque applied to threaded connections does not provide the correlation, response, automatic control or record of make-up parameters.

THREAD COMPOUND / APPLICATION

Thread compounds are often overlooked in establishing make-up procedures. It should be recognized that:

* API recommended make-up torque values are based on the use of API Modified Compound.
* Tapered interference fit threaded connections have a leak path that must be sealed by the compound.
* The use of compounds containing metallic particles, such as API Modified, may not be desireable for use on all connections and in all environments.

Recent test programs have indicated that some connections can be damaged by application of too much thread compound. In one such test, a seal ring coupling, with an internal polymer coating in the "J" area was strain gaged and tested. When made-up using 30 weight motor oil as a lubricant the hoop strain was found to be 1400×10^{-6} in/in.

When API Modified compound was used, the compound became entrapped between the polymer and the seal ring and the resultant hydraulic forces resulted in a hoop strain of 2900×10^{-6} in/in.

Application techniques, as well as the quantity applied, can be important when working with premium connections. The application technique should be considered as a part of the make-up procedure.

WEIGHT TRANSFER

As connections are made-up the suspended joint weight is transferred from the single joint elevator to the box of the joint in the spider. If the transfer of weight takes place too quickly, that is immediately on stabbing, all the load is transferred to one or two threads and galling damage can result at low torques. This type of damage is most likely to occur when soft materials, Corrosion Resistant Alloys and heavy connections are used.

For applications in which weight transfer can become critical, a weight compensating device is recommended. See FIGURE 7.

CONCLUSIONS

Presented has been a brief discussion of the impact of seven factors on the successful make-up of tubing. The intent of this presentation is to promote thoughtful consideration of running procedure requirements. The procedure for make-up of tubing should consider the needs of the application and require make-up procedure controls appropriate for the application. The use of too little control can be as costly as too much control.

Examples of the use of this information to develop successful running procedures follow:

CASE 1. A shallow well is being completed to produce liquid hydrocarbons under low pressure and with no corrodents present using J-55 API 8rnd tubing.

For this type of application only minimum controls need be specified. The need exists for clean connections and monitoring of torque, perhaps by electronic torque gage, although hydraulic gage is adequate.

CASE 2. A well similiar to that described in Case 1, except the application indicates the need for an API Seal Ring Coupling.

For this application consideration should be given to specifying torque-time monitoring to insure that the elastomeric seal remains in place.

CASE 3. The final case involves the use of a high alloy premium connection with metal to metal seals in a critical application.

Applications such as CASE 3 require consideration of all seven factors presented. The use of alignment guides, integral back-up power tongs, connection monitoring and weight transfer compensator equipment could be needed for successfull running of the tubing. If the operator has no experience with the connection, pre-running testing of the make-up procedure might be required.

Tubing can be run successfully with a minimal amount of field problemS if the impact of factors that influence the leak tightness of the connection is considered.

REFERENCES

1. API Recommended Practice 5C1

2. Weiner and True: " A Method of Obtaining Leakproof API Threaded Connections in High Pressure Gas Service".

3. API Bulletin 5A2.

4. " Torque Values of API Joints with Teflon Rings" Nippon Steel report dated 14 February 1986.

5. Marlow, et al: "Damage Characteristics of Premium Casing and Tubing Connections"

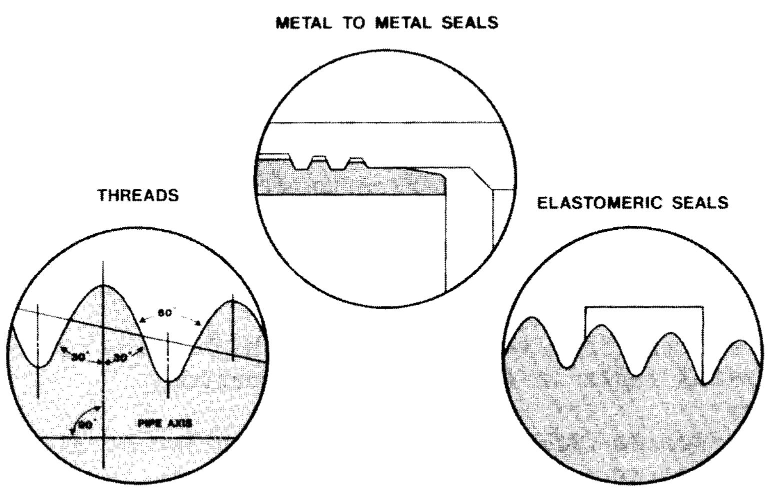


Figure 1—Seal elements

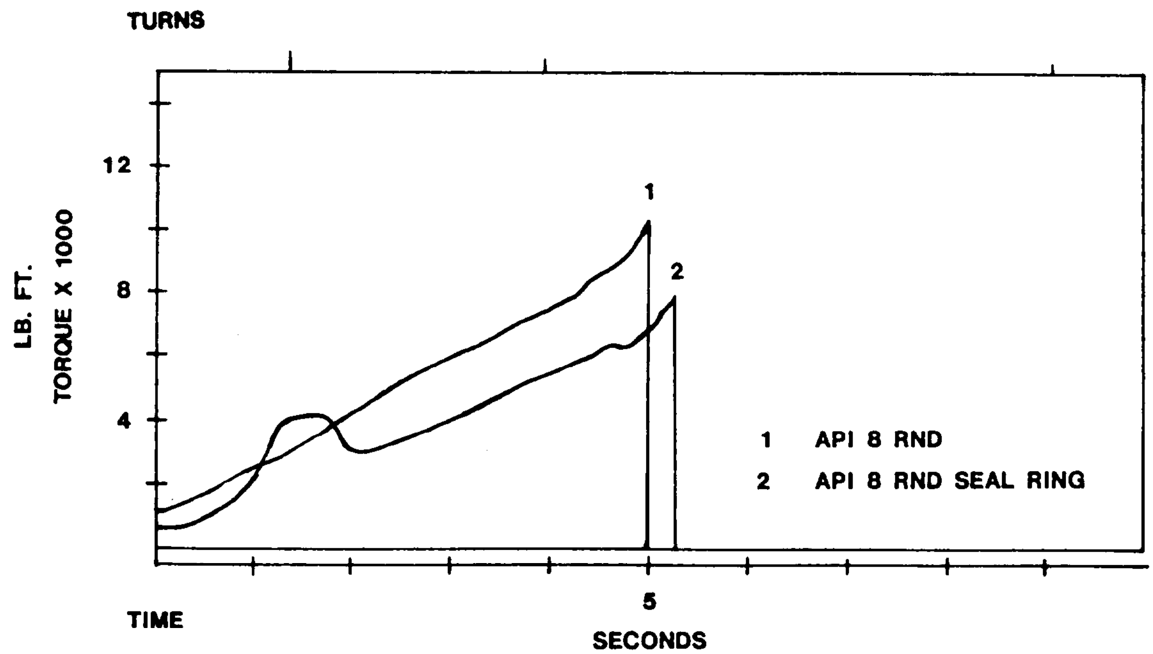
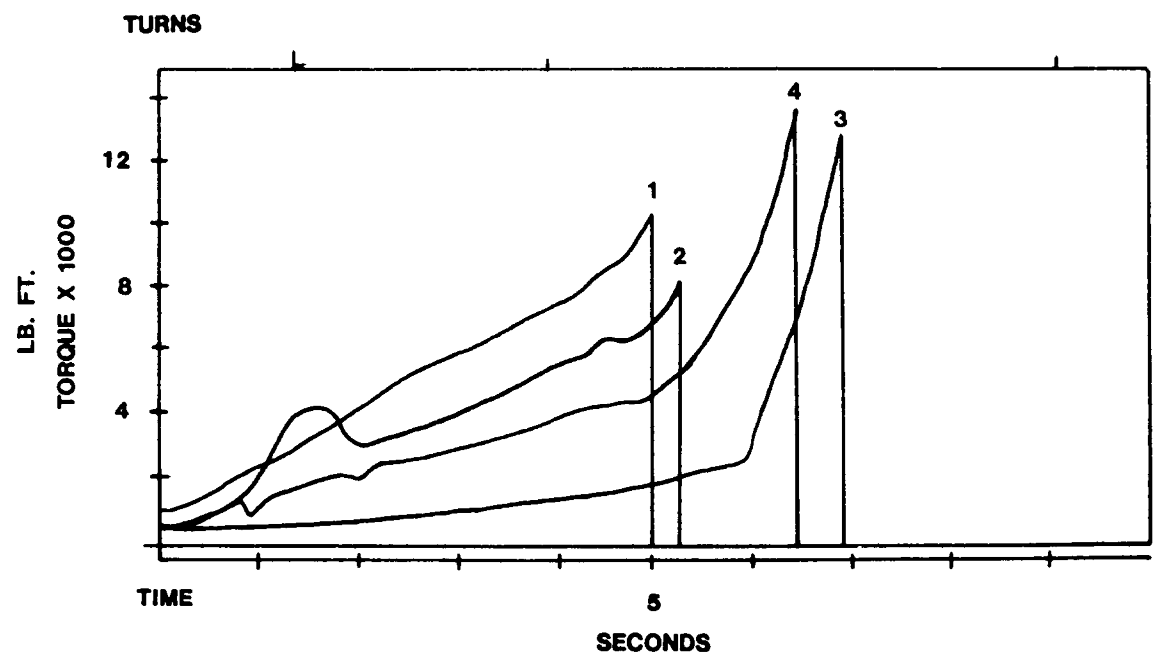
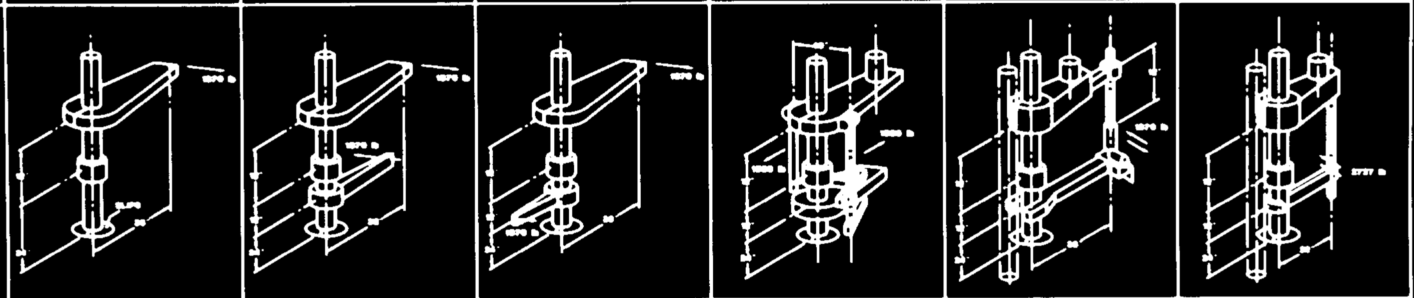
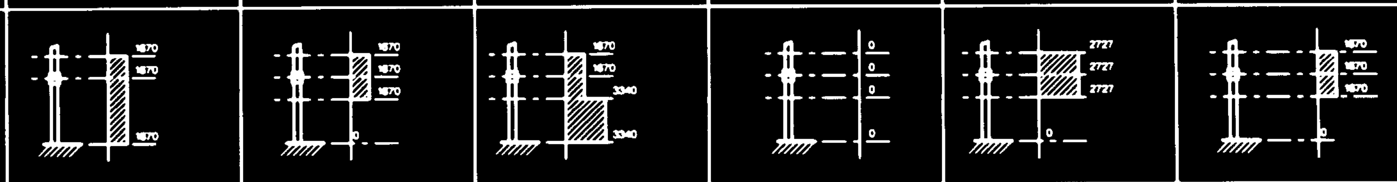
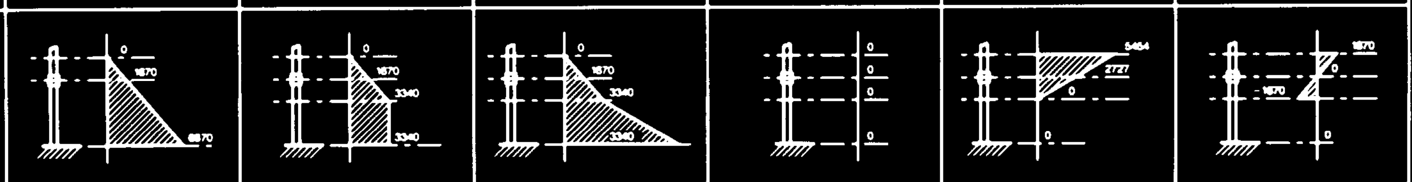


Figure 2



1 API 8 RND
2 API 8 RND SEAL RING
3 PREMIUM CONNECTION WITH TORQUE SHOULDER
4 PREMIUM CONNECTION WITH TANGENRAL SEAL AND TORQUE SHOULDER

Figure 3

	① STANDARD	② WITH RIG TONG	③ WITH RIG TONG	④ G.M.B.H. 7625 TONG WITH HYDRAULIC BACK-UP 34-001	⑤ HK 500 C TONG WITH STIFF ARM BACK-UP	⑥ HK 500 C TONG WITH HYDRAULIC BACK-UP
CONFIGURATION						
PIPE SHEAR FORCE DIAGRAM (lb ft)						
PIPE BENDING MOMENT DIAGRAM (lb)						
TONG MODEL	ALL TYPES	ALL TYPES	ALL TYPES	7-625 GMBH	H.K. 500 C.	H.K. 500 C.
BACKUP MODEL	-	CHAIN TYPE OR RIG TONG	CHAIN TYPE OR RIG TONG	HYDRAULIC - W/L 34-001	H.K. TUBING	HYDRAULIC - W/L 50-100
MAX TORQUE (lb ft.)	N/A	N/A	N/A	15000 & 30000	4500	4500
SPEED (rpm) HIGH GEAR	N/A	N/A	N/A	56 at 40 g.p.m. (15000) 28 at 40 g.p.m. (30000)	113 at 30 g.p.m.	113 at 30 g.p.m.
SPEED (rpm) LOW GEAR	N/A	N/A	N/A	14 at 40 g.p.m. (15000) 7 at 40 g.p.m. (30000)	15 at 30 g.p.m.	15 at 30 g.p.m.
						FIG. 1

Weatherford

Figure 4

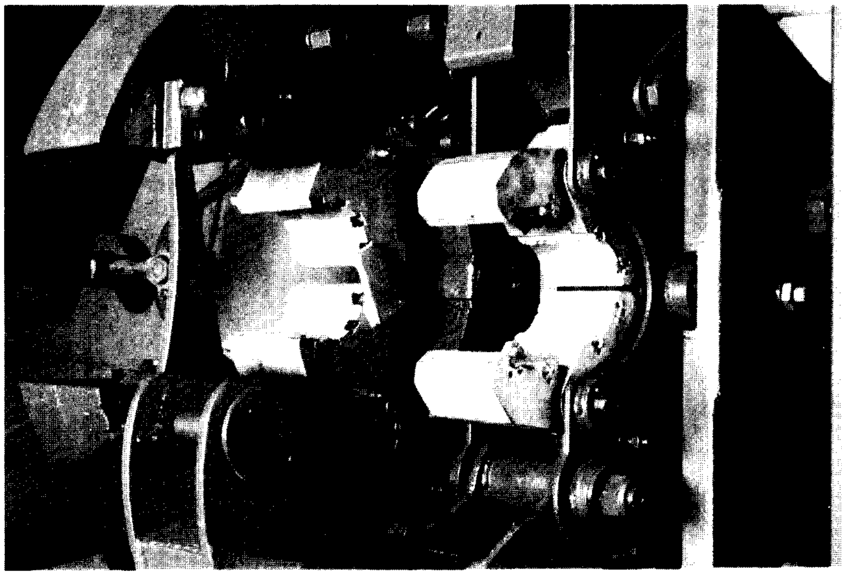
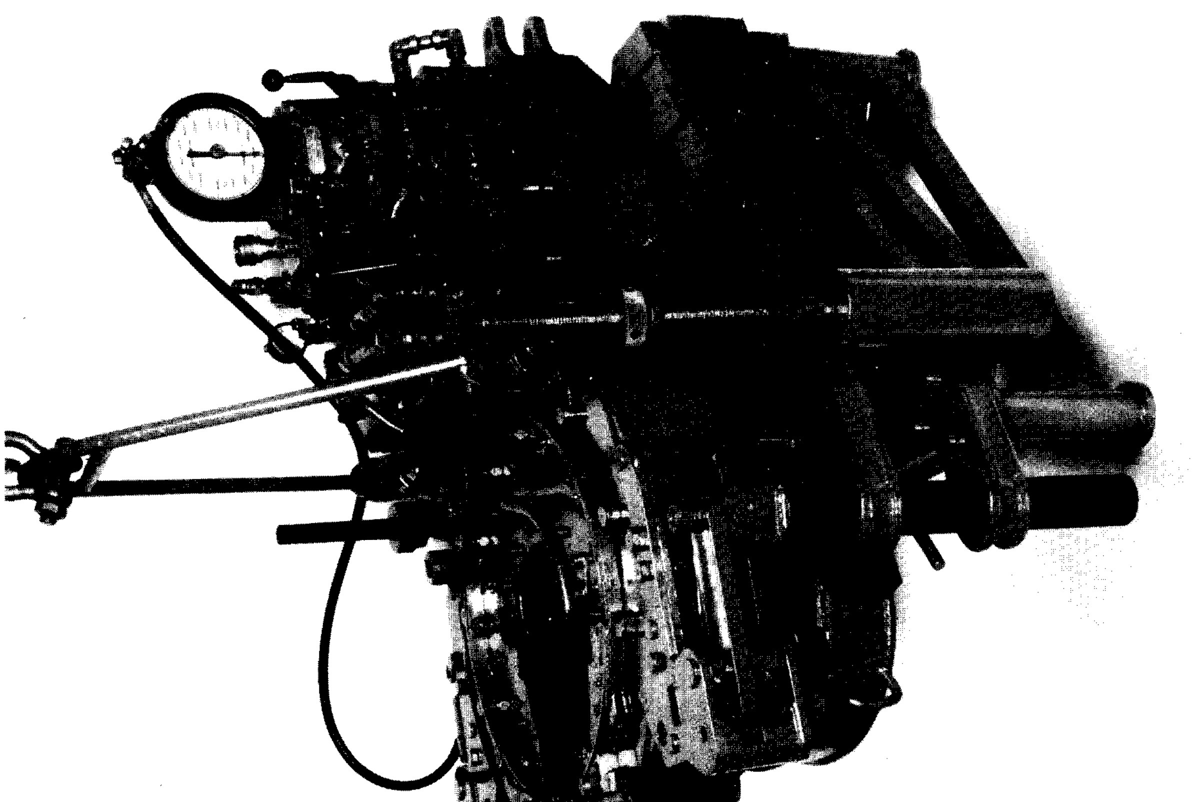


Figure 5



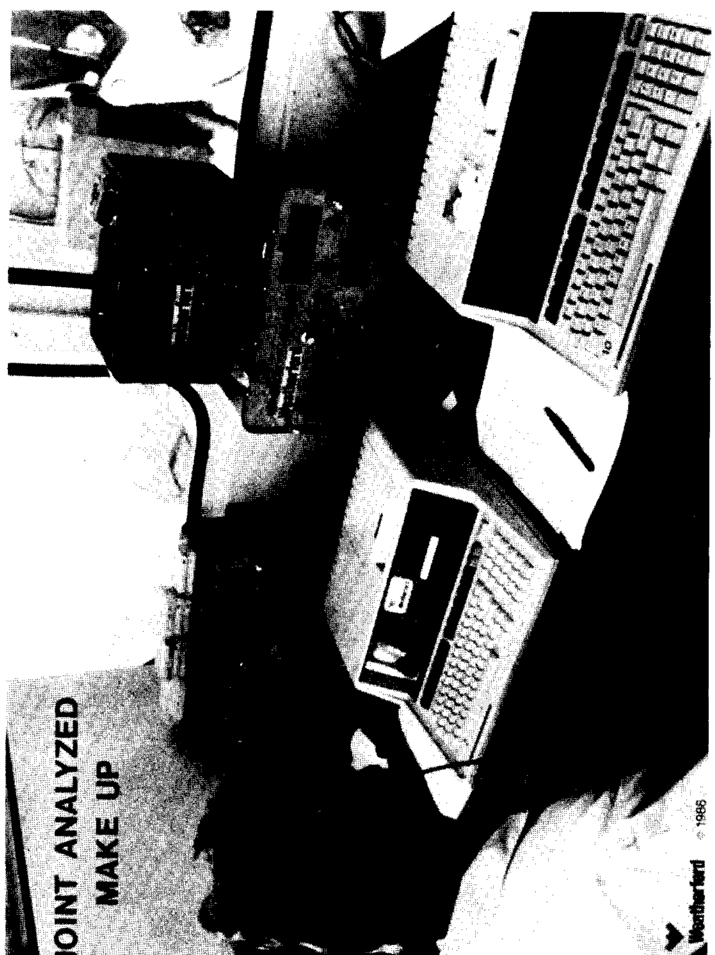


Figure 6

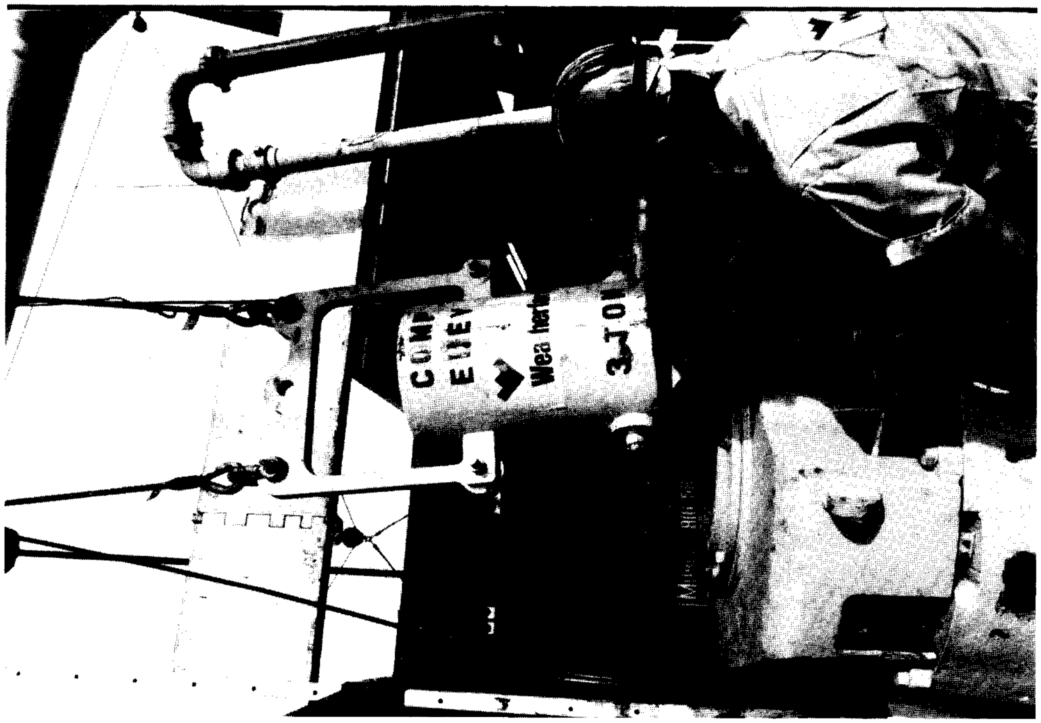


Figure 7