

Box
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Operator
Training Manual
CRU 1342

SECRET

CHEV B8 6439

PU-1342 OPERATOR TRAINING MANUAL

Section I - General Description of the UOP Reforming (Platforming) Process on PU-1342

The Hydrobon-Platforming Unit is designed to produce high quality gasoline motor fuel from straight-run naphthas and gasolines from the crude units.

In the complete unit two different catalytic processes are incorporated. The two processes are known as "Hydrobon" and "Platforming". A "catalytic process" is an operation in which a "catalyst" or "reaction-promoting-substance" is used. In the case of the Hydrobon process, the catalyst either removes or promotes the rearrangement or break-down of the molecules containing sulfur, nitrogen and various metallic compounds. These reactions take place in the presence of a recycle hydrogen stream.

The Platforming process catalyst is used to convert the low quality, low octane straight-run gasoline into high grade, high octane motor fuel. In this process Hydrogen gas is liberated and recycled through the reactors to help promote the reaction.

It is convenient to consider the unit in three sections - Hydrobon, Platformer Reactors and Products Fractionation. Reference to the simplified flow sheet and plot plan, copies of which are included in this section, will assist in visualizing the equipment and sequence of flow.

The prefractionator is used to prepare hydrobon reactor charge from the straight-run gasoline which is available as charge for the unit. Desirable charge should contain a minimum of pentane and lighter. While this light material is not in any way to be considered harmful, it does take up plant capacity which might be used more profitably in the reforming of the heavier gasoline fractions. This is so because this light fraction normally has a reasonably good octane number and Platforming does not appreciably improve the quality from an octane standpoint.

Platformer reactor charge should never have a distillation endpoint higher than ^{350°F}~~300°F~~ in the interest of promoting longer catalyst life.

The straight-run gasoline charged to PU-1342 is a mixture of depentanized gasolines from 6443, 6444 and 6445, 6447 and IU-341 dehexanizer sidestream. These streams are brought together in tankage which is controlled by 163 Pump House. The tanks which are used for PU-1342 charge storage are 77, 78, 93, 2588 and 2590. Tanks 77, 78 and 93 are back-up storage and either 2588 or 2590 tank is used as the unit charge tank. Any time there is any

Section I-Continued

problem with the unit charge flow or charge pump suction pressure, 163 Pump House should be contacted.

The straight run gasoline is first charged to the prefractionator. Hydrobon reactor charge is withdrawn as bottoms product. The light fraction is taken overhead and sent to storage. The prefractionator will also remove overhead hydrogen sulfide, oxygen, water and ammonia, removal of these materials from the reactor charge is desirable.

In the Hydrobon reactor a mixture of recycle gas rich in hydrogen, and the prefractionator bottoms are passed over the Hydrobon catalyst. Here contaminants such as sulfur, nitrogen, and metallic compounds are converted to easily removed forms, or are removed directly from the naphtha charge. This results in a much more suitable charge stock for the subsequent Platforming operation. The hydrogen sulfide formed from the sulfur compounds in the presence of the Hydrobon catalyst is removed from the naphtha stream in the Hydrobon stripper column. Stripper bottoms become the charge material for the Platformer reactors.

In the Platformer Reactor Section the stripper column bottoms are mixed with a hydrogen rich recycle gas stream, heated in exchangers and fired heaters, and charged through the Platforming reactors. Here the desired improvement in octane number is made on the naphtha. Intermediate heaters are provided between the successive reactors to make up the endothermic (that is, requiring or using up heat) heat of reaction. After heat exchange the effluent from the reactor section is cooled and resultant liquid-gas mixture is sent to the products separator.

In the separator the cooled reactor effluent is separated into a liquid stream and a gas stream rich in hydrogen. The major portion of the gas stream is recycled back to the Platformer and Hydrobon reactors. The liquid stream is charged to a depropanizer. Propane and ethane gases formed during the Platforming reaction are taken as overhead product from the depropanizer and are sent to the Ethylene Unit. The bottoms from the depropanizer are charged to the debutanizer, where butane is taken as an overhead liquid product and sent to alkylation unit storage. The bottoms from the debutanizer is Platformate, high octane gasoline, which is sent to gasoline blending storage.

Section I-Continued

Summary of PU-1342 Product Streams

<u>Product Stream</u>	<u>Normal Disposition</u>	<u>Other Possible Dispositions</u>
Prefractionator Overhead	PU-1343 Charge	97 F.H. (Gasoline Treating)
Prefractionator Wet Gas	7944 Gas Plant	Emergency Flare
Prefractionator Bottoms	H.B. Reactor Charge	Charge Tank 2588 or 2590
Hydrobon Stripper Gas	7944 Gas Plant	Product Gas Drum, Emergency Flare
Depropanizer Overhead (Gas)	Refinery Propane (Ethylene Unit)	Product Gas Drum, Emergency Flare
Butane (Liquid)	6341 Tank (Alkylation Unit charge)	
Debutanizer Platformate	No. 1 or 2 Gasoline Line (GG) or No. 4 Gasoline Line (M)	Charge Tank 2588 or 2590
Hydrogen:		
1) H.B. Separator Gas	Hydrogen Gathering System	Product Gas Drum, Emergency Flare
2) H.B. Flash Drum Gas	Product Gas Drum	Emergency Flare
3) Platformer Separator Gas	Hydrobon Reactor, PU-1343, Hydrogen Gathering System	Product Gas Drum, Emergency Flare

Any questions or problems regarding a liquid product stream after the unit battery limits and any time a stream's disposition is changed, 163 Pump House should be notified. Any questions or changes concerning a gas stream or the hydrogen system should be directed to the Gas Dispatcher who is contacted through the Guard Office.

SAFETY /

GENERAL SAFETY PROCEDURES

GULF OIL COMPANY - U.S.

PORT ARTHUR REFINERY

FOREWORD

These General Safety Procedures are prepared for the purpose of putting into written form some of the fundamental procedures to be followed in our refinery in order to prevent injury to our people and damage to equipment.

For these procedures to be effective, for the benefit of all of us, it will be necessary for everyone to be familiar with them and to observe them. Everyone is expected to give his full cooperation in that respect.

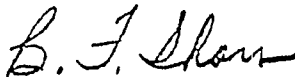
In these General Safety Procedures, you will notice that the terms "should," "shall," and "must" are used. "Should" indicates recommended or advisory steps, and "shall" and "must" indicate mandatory rules.

In the preparation of these procedures, the contents will necessarily be confined to practical limits. We recognize that safety is an inherent part of every job and every operation, no matter how small; however, it is not the intention to include here every procedure which involves the element of safety.

In addition, in our various departments there are written procedures formulated for their particular operations. It would not be practical to include all such procedures in these General Safety Procedures.

State and Federal agencies also issue safety regulations which apply to us. Those regulations will not be duplicated here.

Revisions and additions to these General Safety Procedures will be made and distributed as required.



B. F. Short
Refinery Manager

ELT:cc

11-1-72

CHEV B8 6444

GENERAL SAFETY PROCEDURE NO. 11-1BASIC WORK RULESI. GENERAL

As some of our Basic Work Rules involve safety procedures, they are repeated here in order to be included in our General Safety Procedure record.

II. BASIC WORK RULES

- A. The basic work rules listed below are presently in effect and are issued for the information, guidance and safety of employees. The list obviously does not include all Company rules and regulations.
- B. Each employee is required to abide by the following rules. Your cooperation will be appreciated.
 1. Employees shall be responsible for being at their assigned work locations at their scheduled starting time.
 2. Employees shall not leave their jobs without permission from their foreman, except for normal personal reasons or in case of emergency.
 3. Employees shall eat lunches only at approved lunch periods. ?
 4. Employees scheduled to work 7:30 AM to 4:00 PM shall remain on the job until the 11:30 AM whistle blows, unless given permission by their foreman to do otherwise. Employees may put away their small tools before 11:30 AM.
 5. Employees scheduled to work 7:30 AM to 4:00 PM shall be at their assigned job locations when the 12:00 noon whistle blows, unless given permission by their foreman to do otherwise.
 6. Employees required to return tools or other Company equipment at the end of their workday will be allowed a reasonable time to do so, taking into account the distance of their work from the check-in point and the nature of the tools to be handled. Normally, an employee will be allowed ten minutes to do this. Employees shall remain at their work locations until the end of their shift or schedule unless they have permission from their foreman to do otherwise.
 7. All employees assigned to off-schedule work shall not leave their assigned jobs during the entire shift without permission from their foreman, except for normal personal reasons or in case of emergency.
 8. Employees shall notify their department office or the Medical and Health Services Division when unable to report for work.
 9. Employees shall not smoke in the plant, except in approved smoking areas.

10. Employees shall carry out orders given by their foreman or the person for whom they are working.
11. Employees shall obtain leave of absence by requesting permission from their foreman.
12. Employees shall follow safe work practices and wear protective equipment as required.
13. Employees shall not give or loan their employee identification pass to any other person.
14. Employees shall be responsible for proper use of bath houses.
15. Employees shall be responsible for checking out and properly caring for tools.
16. Employees shall not participate in horseplay.
17. Employees shall use only safety matches in the plant, when matches are authorized, or approved lighters.
18. Employees shall not remove Company property from the plant without proper authorization.

Gulf Oil Company - U.S.
Port Arthur Refinery
Accident Prevention Division

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11-1-72
(From Basic Work Rules dated 2-24-67)

GENERAL SAFETY RULES

1. Hard hat must be worn when outside of control room in battery limits.
2. No canvas type shoes are to be worn. It is recommended that safety shoes be worn.
3. No sleeveless shirts are to be worn.
4. Do not stand directly behind a burner when lighting because the burner may backfire.
5. Open peep holes and lighting holes on heaters cautiously because a positive pressure in the furnace may cause a flow of hot gases through these holes.
6. Use kerosene on torches for lighting burners. Never use gasoline.
7. Use kerosene for cleaning. Never use gasoline.

LTS:mkw:11-25-75

GENERAL SAFETY PROCEDURE NO. 11-14TAGSI. GENERAL

- A. The proper use of tags is an important tool for making our environment a safer place in which to work. The following procedures are established to insure the safety of personnel and equipment.
- B. All employees must know and follow proper tagging procedures. Supervisors must see that those working under their supervision who are authorized to use tags understand and follow these procedures.

II. TYPES OF TAGS AND PROCEDURES

A. Red tags ("Danger")

- 1. Red tags (Gulf Form 9234) shall be used only by Electrical Section personnel, and they shall be used for "tagging out" defective electrical equipment or circuits being worked on by Electricians.
- 2. The Electrical Section must "tag out" equipment or circuits for other personnel (except in power plants) when the equipment or circuits cannot be tagged without entering electrical switch gear or opening disconnect switches with a switch stick.
- 3. In no case shall red tags be removed by anyone other than Electrical Section personnel.
- 4. General Safety Procedure No. 11-15, Red Tags and Locks on Electrical Equipment, governs the use of red tags.

B. White tags ("Do Not Operate")

- 1. White tags (PA Form E-1010) shall be used by Maintenance personnel only (other than Electricians).
- 2. Maintenance personnel (other than Electricians) shall not place their tag on equipment before it has been tagged by the department owning the equipment or by Electricians when specified under section II-A-2.
- 3. Any Maintenance employee (other than Electricians) assigned to work on equipment where unexpected energization or start-up of the equipment or process would be potentially dangerous shall first "tag out" the equipment with a white tag.
- 4. The white tag will be attached in addition to tags placed by Operations or other personnel.
- 5. The person who tags equipment shall write on the tag the reason for tagging and sign his name, department and date.

6. Number of white tags to be applied:

- a. When assignment to work on the same job involves only one work crew of the same craft, only one white tag is required.
 - b. If more than one work crew of the same craft is working because there is more than one job being performed, then each work crew shall add its own tag.
 - c. If more than one craft is involved in the work being performed, then each craft shall add its own tag.
7. If one person is relieved by another before the job is completed, the first person shall remove his tag and a new tag shall be put on by his relief. However, if a person discontinues the job before it is completed without first being relieved by someone else, then he must leave his tag in place.
8. A white tag shall not be removed by anyone other than the person who signed the tag or by an authorized supervisor. An "authorized supervisor" is one who is directing a job on the equipment that has been tagged out and is knowledgeable in the progress of the job. He may remove a tag, or direct that it be removed, only if the employee who signed the tag is away from the plant or not readily available.
9. When the job assignment requires entry into a cooling tower fan stack, in addition to tags as provided above, the equipment shall be also locked out in the safe condition with a padlock. Locks for this purpose only are available in the Zone Maintenance offices and the Weekend Maintenance office and will be issued to employees as required. When the job is complete, locks shall be removed and returned to the office where they were issued.

C. Yellow tags ("Caution")

1. Yellow tags (Gulf Form 9233) shall be used by Operations and Laboratory personnel only.
2. Operations and Laboratory personnel shall use these tags to tag out electrical switches on equipment, to prohibit the operation or use of a valve or line, to warn of a physical hazard that might cause injury to personnel or damage to equipment, etc. (except in locations mentioned in section II-A-2).
3. The person who tags equipment shall write on the tag the reason for tagging and sign his name, department and date.
4. A yellow tag shall not be removed by anyone other than the person who signed the tag or by a knowledgeable individual given the authority and responsibility by his supervisor.

NOTE: EQUIPMENT WHICH HAS BEEN TAGGED OUT WITH ANY OR ALL OF THE ABOVE TAGS SHALL NOT BE PUT IN SERVICE, OPERATED OR TEST-RUN UNTIL ALL TAGS HAVE BEEN REMOVED.

D. Yellow tags (plain, 1-3/8" x 2-3/4")

These tags shall be used on acid and caustic samples and other samples where special precautionary handling is necessary.

E. Tags for HF Alkylation Unit

These are special tags designed exclusively for the HF Alkylation Unit and are described in General Safety Procedure No. 11-41, Handling Hydrofluoric Acid.

F. Blue tags

These tags are for Storehouse purposes to identify stock.

G. Manila tags

These tags are used for information purposes, for tagging steam leaks or any other purpose not specifically covered in this procedure.

H. Manila sample tags

These are printed tags used primarily for Laboratory samples.

Gulf Oil Company - U.S.
Port Arthur Refinery
Accident Prevention Division

JDB:cc

Revised 8-8-75

GENERAL SAFETY PROCEDURE NO. 11-40HOT WORK AND/OR VESSEL ENTRY PERMITSI. GENERAL

- A. When it is necessary to do hot work or to enter a vessel, a Hot Work and/or Vessel Entry Permit must first be obtained in order to safeguard personnel and equipment involved.
- B. Special cases in issuing permits may arise which are not specifically covered in this pamphlet. In such cases the procedures given herein should be used as a guide.
- C. Work done by contractors shall be covered by the provisions of this pamphlet unless other special written agreements have been made between them and the company.
- D. All supervisory personnel must be familiar with these procedures and see that they are followed.
- E. Authorization for issuing permits - Department superintendents are authorized to issue permits. They may also designate other supervisors, No. 1 operators, etc., to do so.
- F. Gas tests
 - 1. Gas tests are made by the Accident Prevention Division upon request for combustible and toxic gases and vapors (hydrogen sulfide, carbon monoxide, aromatics, tetraethyl lead, etc.) and oxygen content of vessels.
 - 2. The person who issues a permit must be sure that the appropriate tests have been made.
- G. Initiating and completing permit
 - 1. Before starting any work which requires a permit, the craftsman or his supervisor will request that the authorized person issue the permit.
 - 2. The permit must be filled out completely before it is signed. If there is no applicable entry to be made on any of the blank lines, a notation to that effect should be made (for example, "none").
 - 3. It is the responsibility of the issuing person to make sure that any restrictive features of the permit are understood by the person to whom he issues the permit.
 - 4. It is the responsibility of the person who receives the permit to check it for completeness and to comply with its provisions. In cases where one permit is for a number of craftsmen or jobs (such as on a unit shut-down) the maintenance supervisor in charge is responsible for seeing that everyone concerned is familiar with the provisions of the permit.

5. The permit shall be good only until the following 7 AM, unless an earlier expiration time is specified.
6. A copy of the permit form is shown in Appendix A, along with explanatory notes concerning information to be shown on it.

H. Extending permit

1. The maximum time limit for a permit shall be 7 AM following the time of issuance. It can be extended when an authorized person obtains another gas test and rechecks the area to make sure that conditions permit extension of the permit.
2. The authorized person shall enter on the reverse side of the permit the new date, starting time, expiration time, gas test result, and his signature.
3. The expiration time of a permit extension shall not be longer than the following 7 AM.
4. If there is any change necessary in provisions shown on the face of the permit, it cannot be extended. In that case a new permit shall be issued. No erasures or alterations shall be made on the face of the permit.

I. Cancelling permit and revalidating

1. A permit automatically becomes invalid when conditions under which it was issued change or if instructions on the permit are not being followed.
2. It is the responsibility of anyone who becomes aware of changes in conditions which might cause fire or exposure to gases to halt work immediately and notify his supervisor.
3. When the condition has been corrected, the permit can be revalidated by the signature of an authorized person on the reverse side.
4. In case of fire, explosion, etc., the permit shall not be altered or destroyed. Work to be done thereafter shall require a new permit, and the original permit cannot be revalidated.

II. HOT WORK PROCEDURES

A. Definition of hot work

1. Hot work is any work in which heat generated or applied is of sufficient intensity to ignite flammable liquids, vapors, or gases, or any other combustible material. The following are examples of operations which are considered hot work in this pamphlet: welding, brazing, burning, open fires, hot forging, hot riveting, dry sandblasting.
2. For clarification, the following categories are not considered hot work in this pamphlet, and a written permit is not required for them:

- a. Operations which are considered less likely to cause ignition (such as using combustion engines, grinding, electric soldering, breaking concrete, power chipping or ripping of metal, using portable electric powered apparatus or lights, and using photographic flashbulbs) are not considered hot work. However, they may be prohibited by area authorities, and for that reason such operations shall not be performed without consent of the area authority.
 - b. Use of flame or heat producing or arcing apparatus which is integrally part of established operations (such as fires in process heaters or boilers, laboratory equipment, and permanently established electrical equipment) is not considered hot work.
 - c. Temporary or permanent smoking pens are not included in this pamphlet. They are requested and approved under other established procedures.
- B. All hot work requires a hot work permit except that done in free burning areas listed in Section II-G.
- C. Multiple area authority
- 1. When two or more departments have equipment in the same area and a hot work permit is required, all of the departments involved shall sign it. The department in charge of the equipment to be worked on shall obtain signatures from the other departments before issuing the permit.
 - 2. The Bulk Oil Department shall sign hot work permits for the area between Avenue A and the turning basin from Gate 26 to the south end of the turning basin, as well as the vicinity of the shore line continuing around the south bank to the turning basin "point." However, this does not include permits for the Main Office, No. 1 Cafeteria, Laboratory, Medical and No. 1 Bath House buildings (which those area authorities will sign), nor to any free burning areas listed in Section II-G.
- D. Preparation of site - The following steps shall be taken to prepare the site and equipment for hot work:
- 1. All connecting lines to a vessel (including process, gas, steam, water, and air lines, as well as level gauge columns, level float columns, and similar reservoir type instruments and/or appurtenances) shall be either blanked or disconnected as close to the vessel as practicable, with the exceptions listed below. If disconnecting is the method used, it shall consist of removal of a sufficiently long part of the line to prevent passage of gas across the gap.
 - a. Lines to equipment in boiler houses need not be blanked or disconnect if the double block valve, bleeder, and tag system is used.
 - b. Water lines to equipment at the Water Treating Plant need not be blanked or disconnected if the valves are closed and yellow-tagged by Operations.

Flammable vapors and liquids and loose combustible materials shall be removed or adequately covered before hot work is authorized. The proximity of other equipment and the possibility of flammable vapor drifting into the hot work area shall also be taken into consideration.

3. Materials which, even though non-flammable, can release toxic vapors when heated shall be removed before hot work is authorized, or else adequate respiratory equipment shall be used. For example, metal which has been in contact with tetraethyl lead solutions shall have scale and rust removed down to bright metal for a distance of at least six inches around the area which will be heated.
4. Sewers and drains in the vicinity of hot work shall be kept covered.
5. A fire watcher shall be kept stationed in the vicinity of hot work with adequate fire fighting equipment when there is a possibility of ignition of any combustible materials.
6. None of the above is intended to prohibit certain hot work on the exterior of a closed vessel in service, such as welding a saddle on a pipe line for a hot tap, sandblasting certain tanks in service, etc.

E. Gas tests for hot work

1. A combustible gas test must be made for every hot work permit, with the following exception: When the person in charge of the area is satisfied that the location is in the open, completely away from any possible sources of gas, and a vessel is not involved, a gas test is not required.
2. The gas test of a vessel shall not be made until after it has been isolated as described in Section II-D-1.
3. When hot work in a free burning area involves a vessel, a combustible gas test of the vessel must be made even though a hot work permit is not required in the free burning area.
4. Hot work shall not be permitted unless the combustible gas test result is zero percent of the lower explosive limit.

F. Hot work on marine vessels

1. Issuing permit - Permits for marine vessel hot work will be issued only by the Bulk Oil Department Dock Foreman or the Senior Loading Foreman on duty.
2. Permissible locations
 - a. The only hot work permitted alongside the docks is in engine rooms or boiler rooms of Company-owned or chartered ships. However, this shall not include any work on the skin of those ships nor any work which would necessitate running welding cables from the dock to the ship.
 - b. Any hot work which is not permitted alongside the docks in 2-a above may be done at the south bank of the turning basin.
3. Handling cargo - Loading or unloading of products is permissible while hot work is being done in the engine rooms or boiler rooms of the ships mentioned above.
4. Location of equipment
 - a. Gas cylinders used in any hot work shall be located within the enclosure of the afterhouse on ships.

- b. Any welding cables strung from the shore to a ship (which is permissible only at the south bank) shall go to the ship's stern, with the ground lead cable grounded inside the living quarters or the engine room or boiler room.
5. Other clearances - It is the responsibility of the Marine Department to notify the Coast Guard before hot work is done aboard a marine vessel and to obtain Certified Gas Chemist certificates when required. (When that is done, the usual refinery gas test is still required, however.)

G. Free burning areas

1. A permit will not be required for hot work in the following areas:

- a. Boiler Shop and under shed west of shop
- b. Tin Shop
- c. Machine Shop and designated sandblast area south of shop
- d. Electric Shop
- e. Water Cooler Repair Shop
- f. Instrument Shop
- g. Pipe Shop and designated area north and west of shop
- h. Lead Shop and storage yard west of shop
- i. Carpenter Shop and designated repair area south of shop
- j. Garage
- k. Locomotive shed
- l. Car repair shed and designated track area
- m. Laboratory maintenance shop
- n. Reclamation Yard
- o. Dump
- p. 1542 Ethylene Unit area between heaters and railroad

2. Additional areas may be designated by agreement with the department superintendent over the area, the Fire Protection Section, and the Accident Prevention Division.

III. VESSEL ENTRY PROCEDURES

A. Definitions

1. Vessel - Vessels are any normally closed enclosures such as tanks, towers, drums, oil reservoirs, tank cars, tank trucks, barge tanks, ship tanks, pipe lines, sewers, and similar equipment. For the purpose of this pamphlet the term also applies to furnaces and to condenser boxes and other open enclosures in which flammable or toxic gases or insufficient oxygen may be present. (Floating roof tank tops are not included in this definition. Procedures for going onto those tank roofs are contained in General Safety Procedure No. 11-32, Going on Floating Roof Tanks in Service.)
2. Vessel entry - Vessel entry is the bodily entry of a person into a vessel so that he is exposed to the contents of the vessel.

- B. All vessel entry requires a vessel entry permit except where it would mean that a department issues a permit to itself to enter its own equipment. In those cases, even though no written permit is required, the other vessel entry procedures shall be followed.

C. Preparation of site - The following steps shall be taken to prepare the vessel for entry:

1. All connecting lines to a vessel (including process, gas, steam, water, and air lines, as well as level gauge columns, level float columns, and similar reservoir type instruments and/or appurtenances) shall be either blanked or disconnected as close to the vessel as practicable, with the exceptions listed below. If disconnecting is the method used, it shall consist of removal of a sufficiently long part of the line to prevent passage of gas across the gap.
 - a. Lines to equipment in boiler houses need not be blanked or disconnected if the double block valve, bleeder, and tag system is used.
 - b. Water lines to equipment at the Water Treating Plant need not be blanked or disconnected if the valves are closed and yellow-tagged by Operations.
2. Corrosive chemicals and other harmful substances shall be removed before vessel entry is authorized unless adequate personal protective equipment is used.

D. Gas test for vessel entry

1. A combustible gas test must be made for all vessel entry.
2. The vessel entry permit cannot be issued unless the gas test result is 50% of the lower explosive limit or below.
3. Toxic gas tests where applicable must be made for all vessel entry unless the result of the combustible gas test or other circumstances (for example, known presence of tetraethyl lead) already require that the maximum respiratory protection be used.

E. Respiratory protection

1. A vessel must be free of combustible and toxic gases and contain sufficient oxygen before it can be entered without respiratory protection.
2. The correct type of respiratory protective equipment shall be provided and worn, depending on the type of gas and concentration encountered. (See General Safety Procedure No. 11-2, Respiratory Protection, for requirements under various conditions.)

F. Portable vessels

1. Tank cars and tank trucks - Tank cars, tank trucks, and similar portable vessels can, for the purposes of the vessel entry section of this pamphlet only, be considered as belonging to the maintenance supervisor during the period of time his people enter to perform their work. Then as stated in Section III-B, a written vessel entry permit will not be required, but the other vessel entry procedures shall be followed.

2. Marine vessels

- a. Marine vessels can, for the purposes of the vessel entry section of this pamphlet, be considered as belonging to the Bulk Oil Department while its own dock personnel enters tanks. Then, as stated in Section III-B, a written vessel entry permit will not be required, but the other vessel entry procedures shall be followed.
- b. Vessel entry by Marine Department personnel or maintenance crews under their direction for the purpose of doing repair work is covered by General Safety Procedure No. 11-34, Handling Ships, Barges and Tugboats at Docks.

Appendix B summarizes the procedures outlined herein and indicates the sections in which those procedures are explained.

In special cases it may be impractical to conform to the above procedures. In these cases minor deviations may be agreed upon by Operations, Engineering, and the Accident Prevention Division as long as the safety of personnel and equipment is not affected. Such deviations, however, are not to be considered permanent modifications of the outlined procedures.

Attachments: Appendix A
Appendix B

Gulf Oil Company - U.S.
Port Arthur Refinery
Accident Prevention Division

ELT:cc

Issued 11-1-72

Front:

PA FORM 12-10

GULF OIL COMPANY - U. S. - PORT ARTHUR REFINERY

HOT WORK AND/OR VESSEL ENTRY PERMIT

CHECK ONE: HOT WORK ☐ VESSEL ENTRY ☐ BOTH ☐

DATE _____ STARTING TIME _____ AM _____ PM EXPIRATION TIME _____ AM _____ PM

ISSUED TO (name of craft or supervisor)

WORK (description of work to be done - for example, welding, sand-blasting, open fire for lead pot, enter for cleaning, etc.)

LOCATION (number of unit, name of vessel, etc.)

LOCATION OF WORKMAN'S EQUIPMENT (location of welding machine, etc., when it should be in certain area)

ROUTE OF CABLES AND BURNING HOSE (specific route when cables or hose should be kept out of certain area)

SPECIAL INSTRUCTIONS (for example, keep sewer covered, have area wet down, keep fire watch at site, etc.)

GAS TEST RESULTS (results of combustible and toxic gas tests reported by Safety Inspector)

(SEE REVERSE SIDE)

SIGNATURE OF AUTHORIZED PERSON

Back:

PERMIT EXTENSION

DATE	STARTING TIME	EXPIRATION TIME	GAS TEST RESULTS	SIGNATURE OF AUTHORIZED PERSON

Do not use this side of permit if conditions have changed from those specified on face of card. Issue new permit.

SUMMARY - GENERAL SAFETY PROCEDURE NO. 11-40

WORK	HOT WORK PERMIT	VESSEL ENTRY PERMIT	BLANK OR DISCONNECT	COMBUSTIBLE GAS TEST	TOXIC GAS TEST
<u>HOT WORK:</u>					
Free burning area, not on vessel	No (II-B)		-	No	No
Free burning area, on vessel	"		Yes (II-D-1)	Yes (II-E-3)	"
Lines to equipment in boiler houses	Yes (II-B)		Yes, or double block, bleeder, and tag (II-D-1-a)	Yes (II-E-1)	"
Water lines to equipment at Water Treating Plant	"		Yes, or close and tag valves (II-D-1-b)	"	"
In open, away from gas, not on vessel	"		-	No (II-E-1)	"
All other hot work	"		Yes (II-D-1)	Yes (II-E-1)	"
<u>VESSEL ENTRY:</u>					
Self-entry in own vessel	No (III-B)		Yes, unless exempted below (III-C-1)	Yes (III-D-1)	Where applicable (III-D-3)
Lines to equipment in boiler houses	Yes (III-B)		Yes, or double block, bleeder, and tag (III-C-1-a)	"	"
Water lines to equipment at Water Treating Plant	"		Yes, or close and tag valves (III-C-1-b)	"	"
Tank cars, tank trucks, marine vessels	No (III-F)		-	"	"
All other vessel entry	Yes (III-B)		Yes (III-C-1)	"	"

CHEV B8 6459

SLT
11-1-72

GENERAL SAFETY PROCEDURE NO. 11-2

RESPIRATORY PROTECTION

I. GENERAL

- A. This procedure shall serve as a guide for the proper selection, use and care of respiratory protective equipment in the Port Arthur Refinery.
- B. Respiratory protective equipment shall be used whenever processes, environment, or chemicals are encountered in a manner capable of harming the body through inhalation.
- C. The Accident Prevention Division shall approve all new types of protective equipment to be obtained for use.

II. EMPLOYEE RESPONSIBILITY

- A. Employees shall use the protective equipment provided in accordance with instructions and training received.
- B. Employees shall guard against damage to the equipment.
- C. Employees shall report any malfunction of the equipment to their supervisor.
- D. Employees who are performing routine tasks shall not borrow emergency respiratory protective equipment which is permanently assigned to a specific location without special permission of the supervisor in charge of the area in which the emergency equipment is kept.

III. SELECTION OF RESPIRATORY PROTECTIVE EQUIPMENT

A. General

- 1. The chemical and physical properties, toxicity, and concentration of hazardous material shall be considered before respiratory equipment is selected.

NOTE: Any deviation in the selection of respiratory protective equipment shall be on the safe side.

- 2. Supervisors shall become familiar with the various types of respiratory protective equipment and their limitations, as the conditions encountered may range from nuisance odors or irritation to those which are immediately dangerous to life.

3. Supervisors shall be responsible for selecting the proper respiratory equipment.
4. A guide to aid in the proper selection of equipment for the most common substances and materials is shown in Appendix A. The equipment listed (or equipment giving a higher degree of protection, if desired) shall be used. Questions concerning unusual circumstances should be referred to the Accident Prevention Division.
5. A form is available for supervisors to give to employees in order to obtain the correct respirator or gas mask from the Tool House. That form, "Request for Respiratory Equipment," is shown in Appendix B.

B. Nature of the hazard

The following is a general guide. For atmospheres containing specific contaminants, see Appendix A.

1. Oxygen-deficient atmospheres

Only self-contained breathing apparatus or supplied-air masks shall be used in any atmosphere that is deficient in oxygen. For the purpose of this procedure, any atmosphere that tests perceptibly lower than the normal 20.8% of oxygen is considered to be oxygen-deficient.

2. Immediately hazardous atmospheres

Only self-contained breathing apparatus, supplied-air masks or canister gas masks shall be used in atmospheres where gases are present in concentrations that would rapidly endanger a person.

3. Not immediately hazardous atmospheres

Chemical cartridge respirators or canister gas masks shall be used for gaseous contaminants. Mechanical filter respirators shall be worn as protection against particulate matter.

C. Work requirements and conditions

The selection of appropriate respiratory protective equipment can only be made after it has been determined what work must be performed, what length of time it will require and under what conditions. For example, emergency repairs requiring a short period of time in an oxygen-deficient atmosphere and with normal access would permit the use of either a self-contained breathing apparatus or a supplied-air mask. However, lengthy tasks or confined areas may permit the use of a supplied-air mask only. Additionally, some contaminants may be absorbed through or irritate the skin upon contact. Consideration must be given to providing the wearer total protection if conditions warrant.

IV. USE OF RESPIRATORY PROTECTIVE EQUIPMENT

A. Restrictions

1. In areas where the user, with failure of the respiratory protective equipment, could be overcome by a toxic or oxygen-deficient atmosphere:
 - a. The user shall have a lifeline attached.
 - b. At least one additional person shall be present.
 - c. Communications, either visual, voice, or signal line, shall be maintained.
 - d. Planning shall be such that at least one individual will be unaffected by any likely incident and have the proper rescue equipment to be able to assist in case of emergency.
2. Respiratory protective equipment shall not be worn when conditions prevent a good face seal such as a growth of beard, absence of dentures, temple pieces on glasses, etc. Also, to assure proper protection, the facepiece fit shall be checked by the user each time he puts on the equipment.
3. Vessel entry is not permitted, even with appropriate respiratory equipment, in atmospheres that test above 50% of the lower explosive limit (LEL).

B. Training

1. For the safe use of any respiratory protective equipment, it is essential that the user be properly instructed in its selection, use and maintenance.
2. Users shall receive fitting instructions which include:
 - a. Demonstrations and practice in how the respiratory protective equipment should be worn.
 - b. How to adjust the equipment.
 - c. How to determine if it fits properly.
 - d. Wearing it in normal air and in a test atmosphere for familiarity purposes.
3. Employees shall be made aware of the capabilities and limitations of respiratory protective equipment that they will be required to use, including how to determine when equipment is expended or out of date.

4. Supervisors shall be responsible for assuring that all employees assigned to their respective areas are properly instructed in the use of emergency respiratory protective equipment kept in that area.
5. After initial training in the use of respiratory protective equipment, supervisors shall periodically evaluate their personnel's ability to use that equipment and arrange for refresher training if required. The form shown in Appendix C, Respiratory Protective Equipment Training Record, shall be maintained as a training record and kept on file in the employee's department.

C. Types of respiratory protective equipment

1. Dust, fume, and mist respirators

- a. Mechanical filter respirators offer protection against airborne particulate matter including dusts, mists, metal fumes and smoke.
- b. Mechanical filter respirators do not provide protection against gases, vapors, or oxygen-deficiency.

2. Chemical cartridge respirators

- a. Chemical cartridge respirators afford protection against light concentrations of certain acid gases and organic vapors by utilizing various chemical agents to purify the inhaled air. They shall not be used in atmospheres which are oxygen-deficient.
- b. Chemical cartridge respirators shall not be used for protection against:
 - (1). Gaseous material that is extremely toxic in small concentrations.
 - (2). Exposure to harmful gaseous material which cannot clearly be detected by odor.
 - (3). Gaseous material in concentrations which are highly irritating to the eyes.
 - (4). Gaseous material which is not effectively stopped by chemical cartridges utilized, regardless of concentration.
- c. Chemical cartridge respirators may be used as shown in Appendix A.
- d. Some chemical cartridges are also identified by coded designations, as shown in Appendix D.

3. Canister gas masks

- a. Gas masks can be used effectively in limited concentrations of certain gases, vapors and particulate matter listed on the canister label and in Appendix A.
- b. Canisters may be referred to by colors or by coded designations, as shown in Appendix D.
- c. Because gas masks are air-purifying devices, they shall not be used in atmospheres which are oxygen-deficient.
- d. If the exposure concentrations are suspected of exceeding the canister limitations, only a self-contained breathing apparatus or a supplied-air mask shall be used.
- e. A gas mask user shall return to fresh air and replace the canister if:
 - (1). Any leakage is detected by smell and taste or by irritation of the eyes, nose or throat.
 - (2). High breathing resistance develops.
 - (3). Uncomfortable heat is noticed in the inhaled air or the canister becomes hot to the touch.
 - (4). A feeling of nausea, dizziness, or ill-being develops.
 - (5). The window indicator on the red type of canister changes color to indicate need for replacement.
- f. When the seal is removed from the bottom of a gas mask canister, the current date shall be entered in the space provided on the label on the canister.
- g. The canister shall be replaced when any one of the following three limits is reached:
 - (1). One year from date of seal removal
 - (2). Expiration date shown on canister
 - (3). When expended, as outlined in 3-e above

4. Hose mask with blower

- a. The hose mask with blower will provide respiratory protection in any atmosphere regardless of the degree of contamination or oxygen deficiency. Other protection may be required for the skin, depending on circumstances.

- b. Whenever a hose mask is used in an atmosphere immediately dangerous to life, a rope shall be attached to the harness and a standby man, or men shall be present in a safe location with suitable rescue equipment.
- c. The entire hose mask assembly including facepieces, harnesses, air hoses, blower and rescue ropes shall be stored in the portable trunks provided and maintained in a usable condition.
- d. Hose mask hoses shall have a minimum inside diameter of one inch, be highly resistant to petroleum vapors, withstand crushing weights, and not exceed 300 feet in length.
- e. Employees shall carefully consider the placement of the hose mask blower and assure that it is located outside any contaminated area.

5. Air-supplied hood

- a. The air-supplied hood is normally used where the user only requires protection against nuisance levels of materials or requires an air flow for cooling purposes.
- b. This equipment shall not be used in any situation where the user would be endangered by loss of air pressure.
- c. Intake of air supply shall be in clean air.

6. Air line respirator

- a. The air line respirator consists of a mask supplied with breathing air by either a compressor or large stationary cylinders.
- b. The air line respirator will provide protection in any atmosphere regardless of the degree of contamination or oxygen deficiency. Other protection may be required for the skin, depending on circumstances.
- c. Whenever an air line respirator is used in an atmosphere immediately dangerous to life, a rope shall be attached to the harness and a standby man or men shall be present in a safe location with suitable rescue equipment.
- d. Care must be exercised to prevent damage to the hose and regulator while in use, and the assembly shall be stored in such a way that damage will be avoided.

7. Cylinder type self-contained breathing apparatus

- a. This self-contained breathing apparatus utilizes compressed breathing air and will provide protection in any atmosphere regardless of contamination or oxygen deficiency. Other protection may be required for the skin, depending on circumstances.

- b. When anticipating the use of this apparatus, consideration shall be given to the service life of the cylinders. Although this equipment should provide breathing air for approximately 30 minutes, extreme exertion or emotional strain may reduce the rated time.
- c. Users of this equipment shall immediately begin exiting the hazardous atmosphere when the low pressure alarm sounds.
- d. Whenever compressed air apparatus is used in an atmosphere immediately dangerous to life, a lifeline shall be attached to the person using the apparatus and a standby man or men shall be present in a safe location with suitable rescue equipment.

8. Chemox self-contained breathing apparatus

- a. Since this equipment is an oxygen-generating, self-contained breathing apparatus, it will provide protection in any atmosphere regardless of contamination or oxygen deficiency. Other protection may be required for the skin, depending on circumstances.
- b. Extreme caution shall be exercised when using this apparatus in confined spaces, as a tear in the breathing bag will make the Chemox inoperable.
- c. Expended Chemox canisters shall be placed in areas free of oil, grease, or anything which might react with oxygen, as the canister may continue to generate oxygen.
- d. The Chemox assembly shall be stored in the portable trunk provided and maintained in a usable condition.
- e. Whenever a Chemox is used in an atmosphere immediately dangerous to life, a lifeline shall be attached to the person using the apparatus and a standby man or men shall be present in a safe location with suitable rescue equipment.

V. MAINTENANCE AND CARE OF RESPIRATORY PROTECTIVE EQUIPMENT

A. Inspection for defects

- 1. All respiratory protective equipment shall be inspected routinely before and after each use.
- 2. Breathing air cylinders shall be maintained at a minimum of 1500 pounds pressure except while being depleted during use. The regulator and any warning device shall be tested during inspections to determine if they function properly.

3. Inspection of equipment shall include a check of the tightness of connections and the condition of the facepieces, headbands, valves connecting tubes, canisters, hoses and regulators. Rubber or elastometer parts shall be inspected for pliability and signs of deterioration. (See Appendix E, Respiratory Protective Equipment Inspection Procedure.)
4. Equipment that is not routinely used but is kept ready for emergency use shall be inspected after each use and at least monthly by supervisors in departments to assure that it is in satisfactory working condition. The form shown in Appendix F, Emergency Respiratory Protective Equipment Monthly Inspection Report, shall be completed by each department, and a copy shall be forwarded to the Accident Prevention Division by the last day of each month. Accident Prevention Division personnel shall also make random inspections.

B. Cleaning of respiratory protective equipment

1. Masks issued for routine use by one person shall be cleaned and inspected by the wearer after each day's use.
2. Masks used by more than one person shall be returned to the Tool House for cleaning and disinfecting after each use.
3. Masks maintained for emergency use shall be returned to the Tool House for cleaning and disinfecting after each use.

C. Repair of respiratory protective equipment

1. Repairs shall be made only by authorized trained persons with parts designed for the equipment.
2. No attempt shall be made to replace components or to make adjustments or repairs beyond the manufacturer's recommendations.
3. Reducing or admission valves or regulators shall be returned to the manufacturer or to a trained technician for adjustment or repair.

D. Storage of respiratory protective equipment

1. Respiratory protective equipment shall be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture or damaging chemicals.
2. Respiratory protective equipment placed in work areas shall be stored in clearly marked compartments which are quickly accessible at all times.

11-2-9

3. Respiratory protective equipment shall be stored so that the face-piece and exhalation valve will rest in a normal position and function will not be impaired by the elastometer becoming set in an abnormal position.
4. Respiratory protective equipment shall not be stored in such places as lockers or tool boxes unless they are in carrying cases or cartons.

VI. To insure an effective respiratory protection program, Accident Prevention Division and Industrial Hygiene representatives will monitor and evaluate various operations to assure that respiratory protective equipment is properly selected, used, cleaned and maintained. Anyone desiring assistance with this procedure should contact the Accident Prevention Division.

Attachments: Appendices A through F

Gulf Oil Company - U.S.
Port Arthur Refinery
Accident Prevention Division

/cc

Issued 2-4-76

CHEV B8 6468

RESPIRATORY PROTECTION REQUIREMENTS

11-2 - Appendix A
(page 1)

MATERIAL OR SUBSTANCE	TYPE OF RESPIRATORY PROTECTIVE EQUIPMENT TO BE WORN
Ammonia	Green canister gas mask. If odor is detected through canister, use self-contained breathing apparatus or supplied air.
Antiknock compounds	From 2 to 20 micrograms per cubic foot, use yellow canister gas mask. Above 20 micrograms per cubic foot, or whenever cleaning tanks, use self-contained breathing apparatus or supplied air.
Arsine	Self-contained breathing apparatus or supplied air.
Asbestos	Dust respirator
Benzene	Up to 200 ppm, use organic vapor cartridge respirator. Up to 14% LEL, use yellow canister gas mask. Above 14% LEL, use self-contained breathing apparatus or supplied air.
Carbon monoxide	Up to 3000 ppm in unconfined space, use red canister gas mask. Above 3000 ppm in unconfined space, use self-contained breathing apparatus or supplied air. In confined space, use self-contained breathing apparatus or supplied air.
Chlorine	Yellow canister gas mask. If odor is detected through canister, use self-contained breathing apparatus or supplied air.
Cumene	Same as benzene.
Cyclohexane	Same as benzene.
Dusts	Dust respirator.
Ethylene	Up to 14% LEL, use yellow canister gas mask. Above 14% LEL, use self-contained breathing apparatus or supplied air.
Furfural	Up to 14% LEL, use yellow canister gas mask. Above 14% LEL, use self-contained breathing apparatus or supplied air.
Gasoline	Up to 14% LEL, use yellow canister gas mask. Above 14% LEL, use self-contained breathing apparatus or supplied air.

MATERIAL OR SUBSTANCE	TYPE OF RESPIRATORY PROTECTIVE EQUIPMENT TO BE WORN
Hydrogen	Above 14% LEL, use self-contained breathing apparatus or supplied air.
Hydrogen cyanide	Self-contained breathing apparatus or supplied air.
Hydrogen fluoride	Supplied-air hoods available on HF Unit (refer to General Safety Procedure 11-41).
Hydrogen sulfide	Up to 14% LEL in unconfined space, use yellow canister gas mask. Above 14% LEL in unconfined space, use self-contained breathing apparatus or supplied air. In confined space, use self-contained breathing apparatus or supplied air.
Insecticides	Cartridge respirator for toxic insecticides.
Metal fumes	Fume cartridge respirator.
Naphtha	Up to 14% LEL, use yellow canister gas mask. Above 14% LEL, use self-contained breathing apparatus or supplied air.
Nickel carbonyl	Self-contained breathing apparatus or supplied air.
Oxygen deficiency	Self-contained breathing apparatus or supplied air. For severe oxygen deficiency, as in inert gas purging of vessels, special additional procedures will be established.
Phenol	Yellow canister gas mask. If odor is detected through canister, use self-contained breathing apparatus or supplied air.
Solvents, paint thinners, degreasers, similar products	Organic cartridge respirator. If odor is detected through cartridge, use yellow canister gas mask.
Sulfur dioxide	Acid gas cartridge respirator, yellow canister gas mask, or self-contained breathing apparatus or supplied air, as dictated by odor entering mask.
Toluene	Same as benzene.
Xylene	Same as benzene.

Front:

PA Form 10-20C	
<u>REQUEST FOR RESPIRATORY EQUIPMENT</u>	
Tool House:	Date _____
_____ is authorized to check out	
following respirator/cartridge/gas mask:	
_____ 7100 respirator (dust)	
_____ R-90N cart. (dust) - R-2000 or R-5000 respirator	
_____ R-51 " (Organic vapors) - R-5000 respirator	
_____ R-52 " (acid gases) - R-5000 respirator	
_____ R-53 " (organic and acid gases) - R-5000 or R-9000	
_____ R-166 " (dusts and fumes) - R-9000 respirator	
_____ R-563 " (organic, acid, dusts, fumes) - R-5000 or R-9000	
_____ R-56 " (dusts and fumes) - R-5000 respirator	
_____ R-58 " (toxic insecticides) - R-5000 respirator	
_____ Yellow canister gas mask	
_____ Green canister gas mask)	Expiration Date _____
_____ Red canister gas mask)	
_____ Supervisor	

Back:

Resp's.	7100 - Effective against nuisance and toxic dusts.
	R-2000- Requires an appropriate cartridge.
	R-5000- Requires two appropriate cartridges.
	R-9000- Belt-mounted. Requires two appropriate cartridges.
Cartridges	R-90N - Nuisance and toxic dusts.
	R-51 - Hydrocarbons.
	R-52 - Sulfur dioxide, etc. Do not use in hydrogen sulfide, hydrocyanic acid gas, or hydrogen fluoride.
	R-53 - See both R-51 and R-52.
	R-166 - Dusts and fumes, including metal fumes.
	R-563 - Organic vapors, acid gases, dusts, and fumes, including metal fumes.
	R-56 - Dusts and fumes, including metal fumes.
R-58 - Toxic insecticides in dust, mist, spray, or vapor form.	
Canisters	Yellow - Organic vapors and acid gases.
	Green - Ammonia.
	Red - Organic vapors, acid gases, carbon monoxide, ammonia, dusts, mists, fogs, smokes.

Department _____

Name	Identification Number	Date of Training	Type of Equipment	Instructor

CHEV B8 6472

Type of equipment:

- 1 - Dust, fume, and mist respirator
- 2 - Chemical cartridge respirator
- 3 - Canister gas mask
- 4 - Hose mask assembly

5 - Air-supplied hood
6 - Air line respirator
7 - Cylinder self-contained
8 - Chemox self-contained

(Part 1)

GAS MASK CANISTER DESIGNATIONS

<u>Atmospheric Contaminants to be Protected Against</u>	<u>Bureau of Mines Type</u>	<u>ANSI K13.1-1967 Canister Color Code</u>
Acid gases	A	White
Acid gases and particulate matter	AE	White with gray stripe around canister near top
Organic vapors	B	Black
Organic vapors and particulate matter	BE	Black with gray stripe around canister near top
Acid gases and organic vapors	AB	Yellow
Acid gases, organic vapors, and particulate matter	ABE	Yellow with gray stripe around canister near top
Ammonia gas	C	Green
Ammonia gas and particulate matter	CE	Green with gray stripe around canister near top
Carbon monoxide	D	Blue
Acid gases, organic vapors, ammonia gas, carbon monoxide, and particulate matter	N	Red

(Part 2)

RESPIRATOR CHEMICAL CARTRIDGE DESIGNATIONS

<u>Atmospheric Contaminants to be Protected Against</u>	<u>Bureau of Mines Type</u>
Organic vapors	B
Organic vapors and particulate matter	BE

2-4-76

CHEV B8 6473

RESPIRATORY PROTECTIVE EQUIPMENT INSPECTION PROCEDURE

I. CANISTER GAS MASK

- A. If the canister seal is not broken, the expiration date shall be checked to assure it has not been exceeded. When the canister seal is broken, the date that it is placed in service shall be indicated on the canister label. Discard canisters one year after removing seals or sooner, if canister is expended or becomes outdated. Expired or expended canisters shall be returned to Tool House and replaced immediately.
- B. The breathing hose shall be stretched and examined closely for any breaks or holes. (Minor cracking in the hose surface between corrugations will not disqualify the hose for service.)
- C. The facepiece and head straps shall be pulled on with a firm tearing motion to be sure that the facepiece will not tear or the head straps break when they are put in use.
- D. Facepiece lenses shall be examined for evidence of chipping or cracking that may permit leakage. Damaged lenses shall be replaced.
- E. The exhalation valve at the bottom of the facepiece shall be examined to assure that it functions properly.
- F. The canister hose shall be securely attached to the facepiece and canister with a gasket in place.

II. CARTRIDGE OR FILTER RESPIRATORS

- A. The respirator shall be inspected as described in I-C and I-E.
- B. Cartridges or filters that are visibly ineffective due to an accumulation of foreign matter or that permit odors shall be replaced.

III. HOSE MASK WITH BLOWER

- A. The hose mask shall be inspected as described in I-B through I-E.
- B. Hose gaskets shall be inspected and replaced if defective.
- C. The blower's crank handle shall be turned to assure that the blower is operable and provides sufficient air.

- D. A rescue harness with "D" ring and enough 3/4-inch manila rope to equal the length of the blower hose shall be in the case and shall be examined for defects.

IV. AIR SUPPLIED HOOD

- A. The hood shall be inspected for cracks or holes.
- B. The air hose and fittings shall be in good condition.
- C. The lenses shall be examined for excessive pitting, scratches or other defects which would affect good vision.

V. AIR LINE RESPIRATOR

- A. This type of equipment shall be inspected as described in I-C through I-E.
- B. The air hose, hose connections, and regulator shall be in good condition.
- C. The harness shall be inspected for rips or other defects.

VI. CYLINDER TYPE SELF-CONTAINED BREATHING APPARATUS

- A. This type of equipment shall be inspected as described in I-B through I-E.
- B. Cylinders of stored units that do not have a minimum of 1500 pounds of pressure shall be taken to the Fire Station and exchanged for a full cylinder.
- C. The low pressure alarm shall be tested to assure that it functions properly.
- D. The harness shall be inspected for rips or other defects.

VII. CHEMOX SELF-CONTAINED BREATHING APPARATUS

- A. The Chemox assembly shall be inspected as described in I-B through I-E.
- B. The canister seals shall be examined to assure that they have not been broken.
- C. The breathing bags shall be examined for any breaks or tears.
- D. The signal bell shall be tested to assure that it functions properly.

Monthly Inspection Report

Date _____

Department _____

[illegible]

Department Head

Under each type of equipment, indicate number on hand.

For interaction procedure, see Appendix E of General Safety Procedure 11-2.

FIRE CONTROL /

P U 1342
FIRE CONTROL PLAN

1. Any person discovering a fire is responsible for reporting the fire. A card posted at the unit phone shows the procedure for reporting a fire:

The Method of Reporting a Fire on This Unit is:
Dial 2200 (Fire Protection Section)
Report: FIRE - Platforming Unit 1342 -
Section II
Indicate whether 1, 2, or 3 Alarm.

2. Fires on P U 1342 will be either oil, electrical, or trash fires.
3. In the event of a fire ON THE UNIT, the No. 1 Operator will be responsible for all fire fighting activity until relieved by the Unit Foreman, Shiftforeman, or the Fire Chief. The Inside Assistant Operator will remain in the Control Room. All other operators will report to the No. 1 Operator for duties.
4. In the event of a fire IN SECTION II, the man designated by the No. 1 Operator will go directly to the scene of the fire and report to the person in charge.
5. In the event of fires in OTHER FIRE SECTIONS, one assistant, designated by the No. 1 Operator, will go to the Cracking Department Shiftforeman's Office for transportation to the scene of the fire, when he hears the whistle at 15 BH or is notified by the Shiftforeman.
6. Attached are three plot plans of the unit showing location of:
 - a. All fire control equipment and type.
 - b. Electrical switch gear and master switches.
 - c. Block valves on lines entering and leaving unit.

J. M. Cain

TBL:jdl: 8/1/73

Attachments

C: WDD ✓
RJW
Unit

CHEV B8 6478

28TH

W.H.

Control Room

Compressors

Booster Compressors

Pump Row

Towers

Access

Ave. F

PU 1342

RX

RX

PH-401 Heater

RX

PH-400 Heater

Heaters

RX

27TH STREET

W.H.

WATER FIRE HYDRANT

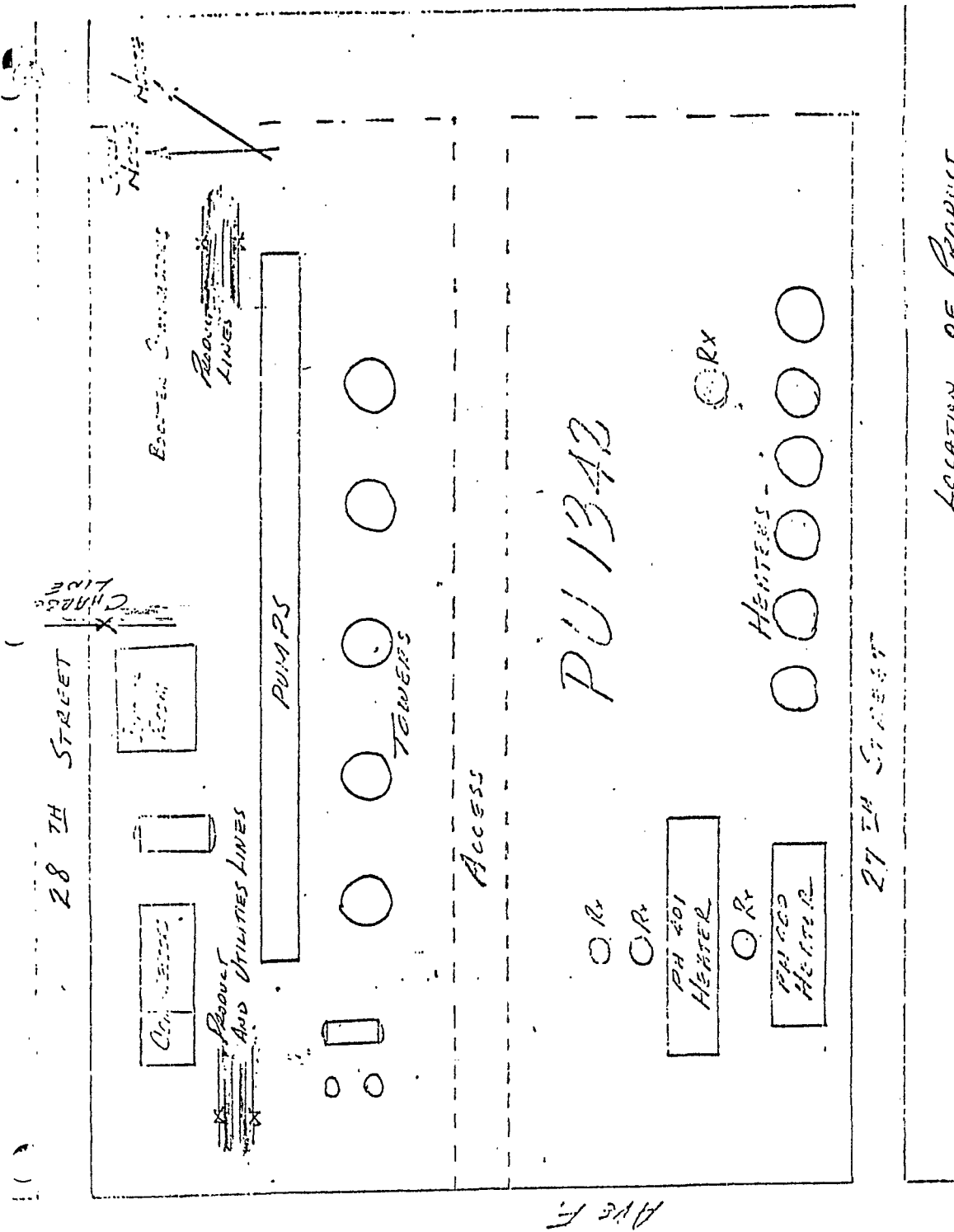
Foamite

Small dry chemical

LARGE dry chemical

CALLER NORTH

1342



LOCATION OF PRODUCT
AND CHARGE LINES
T/F 1342 PU 1342

5/21/11

PJ 1343

12x

CP₂

23-11-77
10:45 AM

C.Rx

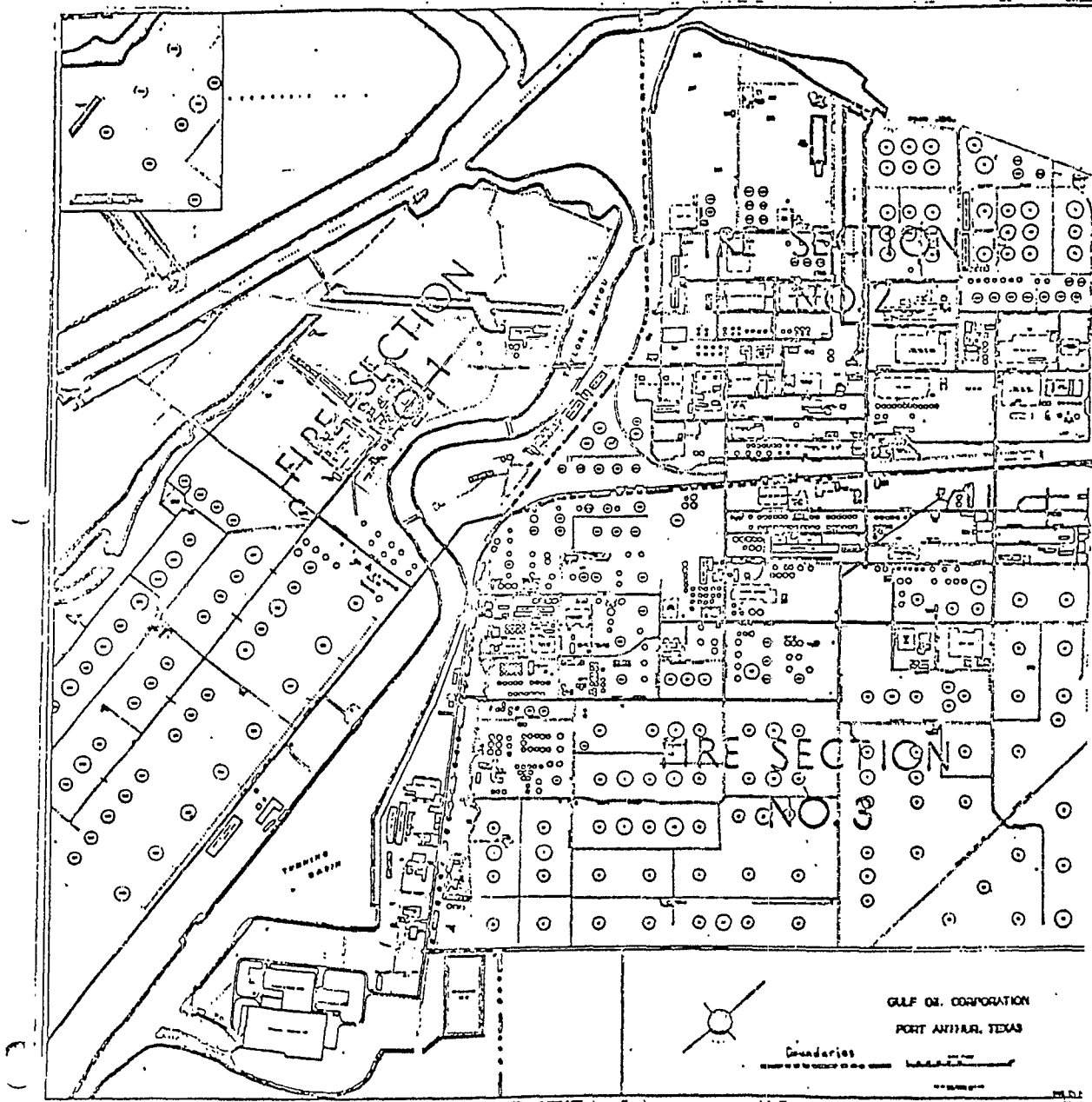
○

2000

4-22-74

27-5-31

LOCATION OF ELECTRICAL SWITCHES AT PU1342



Revised: May 5, 1969

CHEV B8 6482

FIRE! PROTECTION



Gulf Oil Co. U.S.
Port Arthur Refinery

CHEV B8 6483

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DID YOU KNOW ?

1. THE LARGEST LOSS OF LIFE BY FIRE IN A SINGLE BUILDING OCCURRED IN CHICAGO, ILLINOIS ON DECEMBER 30, 1903, WHEN 602 PERSONS WERE KILLED IN THE NEW FIRE RESISTIVE IROQUOIS THEATRE.
2. THE LARGEST LOSS OF LIFE BY FIRE IN THE UNITED STATES OCCURRED ON OCTOBER 8, 1871. ISOLATED FIRES IN THE GREEN BAY AREA OF WISCONSIN ENTERED FOREST LAND AND SPREAD RAPIDLY OVER 1,280,000 ACRES. THE FIRE LEVELED PESHTIGO AND AT LEAST 16 OTHER TOWNS, AND CAUSED DEATHS CONSERVATIVELY ESTIMATED AT 1,152 (WITH SOME FIGURES AS HIGH AS 2,000).
3. THERE IS AN ANNUAL TOLL OF 12,000 DEATHS BY FIRE IN THE UNITED STATES ALONE. THE ANNUAL TOLL IN CANADA IS 600.
4. LOSS OF LIFE BY FIRE RANKS THIRD AMONG CAUSES OF ACCIDENTAL DEATH, BEING LED ONLY BY AUTO ACCIDENTS AND FALLS.
5. FROM 1950 TO 1965, THE POPULATION IN THE UNITED STATES INCREASED 28% AND THE ANNUAL DEATH RATE BY FIRE INCREASED 20%.
6. IN A STUDY FROM 1960 TO 1964, IT WAS FOUND THAT 17.6% OF FIRE DEATHS HAPPEN TO CHILDREN UNDER 5 YRS. OF AGE, 10% TO THE 5 TO 14 YEAR OLDS, 44.7% TO THOSE IN THE 15 TO 64 YEARS AGE BRACKET, AND 27.7% TO THOSE OVER AGE 65.
7. THE GREATEST CAUSE OF DEATH BY FIRE IS FROM GASES OR PRODUCTS OF COMBUSTION RESULTING IN ASPHYXIATION/OR ANOXIA (RESIDENTIAL DWELLINGS).
8. THE THREE MAIN FACTORS RESPONSIBLE FOR THE FAILURE OF PERSONS TO ESCAPE FROM FIRES ARE: (1) BEING ASLEEP, (2) BEING FELLED BY SMOKE OR HEAT, AND (3) TOO YOUNG.

9. THE TWO MAIN FACTORS RESPONSIBLE FOR THE SPREAD OF SMOKE AND FIRE RESULTING IN LOSS OF LIFE ARE: (1) OPEN STAIRWAYS, AND (2) COMBUSTABLE WALL FINISH.
10. THE MAJOR CAUSE OF CLOTHING IGNITION IS SMOKING.
11. CONSERVATIVE ESTIMATES INDICATE THAT AT LEAST 5,000 INJURIES, INCLUDING SEVERAL DEATHS AND 1,400 FIRES, ARE CAUSED BY FIREWORKS EACH YEAR.
12. THE LARGEST LOSS OF LIFE BY FIRE OCCURS IN (1) URBAN DWELLINGS, (2) RURAL DWELLINGS, (3) APARTMENTS, HOTELS, LODGINGS, DORMATORIES, ETC., AND (4) AIRCRAFT.
13. FROM 1961 TO 1966, THE AVERAGE ANNUAL DIRECT PROPERTY FIRE LOSS IN THE UNITED STATES AMOUNTED TO \$1,693,200,000.

REPORTING FIRES

A. RESPONSIBILITY

ANY PERSON DISCOVERING A FIRE IS RESPONSIBLE FOR REPORTING IT (FIRE DEPARTMENT EXTENSION 2200). THE FIRE PROTECTION SECTION MUST BE NOTIFIED OF ALL FIRES, REGARDLESS OF THEIR MAGNITUDE, SO THAT PRECAUTIONS MAY BE TAKEN TO ASSURE THAT THE FIRE IS BROUGHT UNDER CONTROL AND EXTINGUISHED, AND SO THAT THE FIRE CAN BE PROPERLY REPORTED.

B. DEFINITION OF ONE-, TWO-, AND THREE-ALARM FIRES

1. ONE ALARM FIRES

A ONE ALARM FIRE IS ONE WHICH WOULD CAUSE ONLY MINOR DAMAGE TO PROPERTY OR EQUIPMENT, NOT ENDANGER PERSONNEL, AND MAY BE CONTROLLED AND EXTINGUISHED WITH THE PERSONNEL AND EQUIPMENT AVAILABLE WITHIN THE UNIT.

2. TWO ALARM FIRES

A TWO ALARM FIRE IS ONE WHICH WOULD CAUSE MAJOR DAMAGE TO PROPERTY AND EQUIPMENT, ENDANGER THE LIVES OF SOME FEW PEOPLE, AND REQUIRE ADDITIONAL ASSISTANCE TO CONTROL AND EXTINGUISH.

3. THREE ALARM FIRE

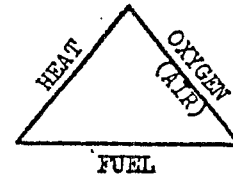
A THREE ALARM FIRE COULD CAUSE GRAVE DAMAGE TO PROPERTY AND EQUIPMENT, SERIOUSLY ENDANGER THE LIVES OF MANY PEOPLE, AND REQUIRE MAXIMUM ADDITIONAL ASSISTANCE AVAILABLE TO CONTROL AND EXTINGUISH. (THIS MAY INCLUDE COMMUNITY FACILITIES IN ADDITION TO REFINERY FIRE FIGHTING EQUIPMENT).

REMEMBER: REPORT FIRES TO EXTENSION 2200.

FIRE

THE CHEMISTRY OF FIRE

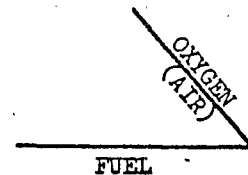
TO HAVE A FIRE, THREE ELEMENTS MUST BE BROUGHT TOGETHER IN BALANCE; FUEL, HEAT, AND OXYGEN. FIRE IS A CHEMICAL REACTION RESULTING FROM COMBINING A COMBUSTIBLE SUBSTANCE--FUEL; WITH OXYGEN AND HEAT. THIS IS CALLED THE FIRE TRIANGLE, IN OTHER WORDS, FUEL HEATED TO ITS IGNITION TEMPERATURE WITH A SUFFICIENT AMOUNT OF OXYGEN WILL ALWAYS RESULT IN FIRE. REMEMBER--IN ORDER TO BURN, ALL FUELS MUST BE IN A GAS OR VAPOR FORM.



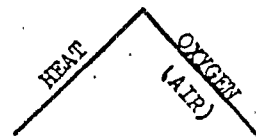
PRINCIPLES OF EXTINGUISHMENT

THE FIRE GOES OUT IF ANY ONE OF THE THREE SIDES OF THE FIRE TRIANGLE IS REMOVED. THIS IS THE BASIS OF FIRE EXTINGUISHMENT.

HEAT CAN BE TAKEN AWAY BY COOLING OR QUENCHING, AND THIS IS DONE BY APPLYING SOMETHING THAT WILL ABSORB THE HEAT. WATER IS AN EFFICIENT COOLER OR QUENCHER OF FIRE, AND IS USED MORE THAN ANY OTHER AGENT FOR COOLING FIRES. IT IS APPLIED IN THE FORM OF A SOLID STREAM, FINELY DIVIDED SPRAY OR FOG, OR USED IN FOAM.



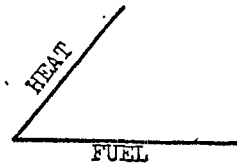
FUEL CAN SOMETIMES BE REMOVED FROM A FIRE, BUT THIS IS USUALLY DIFFICULT OR DANGEROUS. WE CAN PUMP OIL FROM AN INVOLVED TANK OR VESSEL TO REMOVE AS MUCH FUEL AS POSSIBLE



OR IF FLOWING LIQUIDS OR GASES ARE BURNING FROM A LEAK IN A PIPE, IF A VALVE CAN BE CLOSED THE FIRE WILL GO OUT. WHEN FUEL IS REMOVED FROM A FIRE, WE STARVE IT.

THE FUEL LEG OF THE TRIANGLE IS VERY IMPORTANT IN FIRE PREVENTION. IT IS EASY TO REMOVE FUEL TO PREVENT FIRES. WE DO THIS BY PRACTICING GOOD HOUSEKEEPING AT HOME AND ON THE JOB. ALL UNNECESSARY FUELS SHOULD BE PROMPTLY REMOVED FROM OUR WORK AREAS. AT HOME; ATTICS, CLOSETS, GARAGES, ETC. SHOULD BE AS FREE OF UNNECESSARY FUELS AS POSSIBLE. GRASS SHOULD BE CUT AND REMOVED FROM AROUND BUILDINGS. A MINIMUM OF FLAMMABLE LIQUIDS SHOULD BE KEPT, AND THEY SHOULD BE STORED IN APPROVED STORAGE CANS, AWAY FROM ALL SOURCES OF IGNITION. FLAMMABLE LIQUIDS SHOULD NEVER BE USED FOR CLEANING PURPOSES.

OXYGEN IS TAKEN AWAY FROM A FIRE BY COVERING IT WITH A WET BLANKET, CHEMICAL OR MECHANICAL FOAM, PLACING A LID ON A SKILLET OR POT, CLOSING THE HATCH ON A TANK OR VESSEL, ETC. OXYGEN IS DISPLACED OR DISPERSED BY ADDING AN INERT GAS THAT IS HEAVIER THAN AIR INTO THE BURNING VAPORS. CARBON DIOXIDE (CO_2) IS MOST WIDELY USED FOR THIS PURPOSE. WHEN WE EXTINGUISH A FIRE BY REMOVING THE OXYGEN, WE HAVE SMOTHERED IT.



CAUSES OF FIRES

MOST FIRES (70% to 80%) COULD HAVE BEEN PREVENTED. CARELESSNESS OR THE MISUSE OF FUELS IS THE CAUSE OF MANY FIRES, BUT BASICALLY, FIRES ARE STARTED BY A SOURCE OF HEAT OCCURRING IN AN UNWORKED, UNPLANNED AREA. IN INDUSTRY THE SOURCE OF HEAT IN THE MAJORITY OF FIRES CAN BE TRACED TO THE FOLLOWING CAUSES:

1. OPEN FLAMES OR HIGH TEMPERATURES - HEATERS, WELDING AND BURNING, FLARES, HEATED PIPES AND SURFACES.
2. FRICTION - HOT BEARINGS AND SEALS.
3. ELECTRICITY - DEFECTIVE WIRING, SPARKS, HEAT RESISTANCE, STATIC ELECTRICITY.
4. CHEMICAL REACTIONS - SPONTANEOUS IGNITION, OXIDIZING AGENTS, USE OF REAGENTS AND ACIDS.

IN HOMES, THE MAJOR CAUSES OF FIRE ARE:

1. SMOKING AND MATCHES.
2. HEATING DEFECTS.
3. MISUSE OF ELECTRICITY.
4. KITCHEN HAZARDS.
5. MISUSE OF FLAMMABLE LIQUIDS.

CLASSIFICATION OF FIRES

FIRES HAVE BEEN DIVIDED INTO THREE CLASSES TO INDICATE THE NATURE OF THE FUELS INVOLVED.

CLASS A - THIS CLASS OF FIRE OCCURS IN ORDINARY COMBUSTABLE MATERIALS SUCH AS WOOD, PAPER, TEXTILES, RUBBISH, ETC. THE QUENCHING AND COOLING EFFECT OF WATER OR SOLUTIONS CONTAINING LARGE PERCENTAGES OF WATER (FOAM) IS MOST EFFECTIVE. THIS REDUCES THE TEMPERATURE OF THE BURNING MATERIAL TO BELOW ITS VAPORIZATION POINT.

CLASS B - THIS CLASS OF FIRE OCCURS IN VAPOR AND AIR MIXTURE OVER THE SURFACE OF FLAMMABLE LIQUIDS, SUCH AS GASOLINE, SOLVENTS, PAINTS, LUBRICATING OILS, AND GREASES. A SMOTHERING OR BLANKETING EFFECT IS NECESSARY TO EXTINGUISH THIS CLASS OF FIRE.

FOAM, DRY CHEMICAL AND CARBON DIOXIDE (CO₂) ARE USED TO EXTINGUISH

CLASS B FIRES. WATER SPRAY OR FOG CAN BE USED ON HEAVY OILS DEPENDING ON THE CIRCUMSTANCES. STEAM IS AN EXCELLENT AGENT TO PREVENT AS WELL AS EXTINGUISH SMALL UNIT FIRES.

CLASS C - THESE ARE FIRES INVOLVING ELECTRICAL EQUIPMENT SUCH AS MOTORS, GENERATORS, ELECTRICAL APPLIANCES, SWITCH PANELS, ETC., AND FIRES IN THE PROXIMITY OF ELECTRICAL DISTRIBUTION LINES. NON-CONDUCTING EXTINGUISHING AGENTS MUST BE USED FOR THIS CLASS FIRE. DRY CHEMICAL OR CARBON DIOXIDE EXTINGUISHERS ARE NON-CONDUCTORS AND ARE SAFE TO USE ON ELECTRICAL FIRES. FOAM AND WATER TYPE EXTINGUISHERS, AND STREAMS SHOULD NOT BE USED. THEY CONDUCT ELECTRICITY AND THEIR USE COULD RESULT IN INJURY. FUEL IN A CLASS C FIRE COULD BE EITHER A OR B OR A COMBINATION OF BOTH WITH THE ADDED PROBLEM OF ENERGIZED ELECTRICAL WIRING OR EQUIPMENT, PRESENTING A SHOCK HAZARD.

FIRE EXTINGUISHERS

MOST FIRES START SMALL ENOUGH TO BE EXTINGUISHED WITH FIRE EXTINGUISHERS. FOR THIS REASON, EACH EMPLOYEE SHOULD BE THOROUGHLY FAMILIAR WITH THE LOCATION AND PROPER OPERATION OF ALL FIRE EQUIPMENT IN THEIR WORK AREA. FIRE EXTINGUISHERS ARE DESIGNED FOR SMALL FIRES AND MUST BE USED CLOSE TO THE BURNING MATERIAL. DON'T EXPECT FIRE EXTINGUISHERS TO TAKE THE PLACE OF EQUIPMENT DESIGNED FOR LARGE FIRES. THEREFORE, BE CERTAIN THAT ALL FIRES ARE PROMPTLY AND CORRECTLY REPORTED TO THE FIRE STATION: - EXTENSION-2200.

HAND FIRE EXTINGUISHERS
IN USE IN THE REFINERY

EXTINGUISHING AGENT	EXTINGUISHER TYPE AND/OR SIZE	CLASS OF FIRE BEST USED ON
WATER	2½ GALLON (PRESSURIZED)	A
DRY CHEMICAL	20 POUNDS OF DRY CHEMICAL (CO ₂ CARTRIDGE)	B - C
	20 POUNDS OF DRY CHEMICAL (N ₂ -PRESSURIZED)	B - C
	30 POUNDS OF DRY CHEMICAL (CO ₂ CARTRIDGE)	B - C
	150 POUNDS OF DRY CHEMICAL (WHEELED)	B - C
	350 POUNDS OF DRY CHEMICAL (WHEELED)	B - C
CARBON DIOXIDE	5 POUNDS OF CO ₂	B - C
	15 POUNDS OF CO ₂	B - C
	20 POUNDS OF CO ₂	B - C
	50 POUNDS OF CO ₂	B - C
FOAM	40 GALLON (WHEELED)	A - B

THE LETTERS REFER TO THE CLASS OF FIRES ON WHICH THE USE OF THE PARTICULAR EXTINGUISHER IS APPROVED FOR MOST EFFECTIVE FIRE EXTINGUISHMENT.

CARBON DIOXIDE AND DRY CHEMICAL TYPE EXTINGUISHER MAY BE USED ON CLASS A FIRES BUT ARE NOT AS EFFECTIVE AS ON OTHER CLASSES OF FIRES.

FIRE EXTINGUISHER FACTS

TYPE OF EXTINGUISHER	FOR WHAT KIND OF FIRE	CONTENTS	HOW TO OPERATE	HOW THEY EXTINGUISH
PRESSURIZED WATER	CLASS "A" (WOOD, PAPER, TEXTILES, ETC.)	PLAIN WATER AIR PRESSURIZED	PULL PIN SQUEEZE HANDLE (KEEP UPRIGHT)	REDUCE TEMPERATURE BY COOLING AND QUENCHING *DANGER - DO NOT USE ON CLASS "C" FIRES (ELECTRICAL)
DRY CHEMICAL (CARTRIDGE OPERATED)	CLASS "B"- "C" (OIL AND ELECTRICAL)	BICARBONATE OF SODA - CO ₂ CARTRIDGE	REMOVE HOSE PUSH PLUNGER SQUEEZE NOZZLE	SMOTHERS BY DISPLACING OR DILUTING FLAMMABLE VAPORS
DRY CHEMICAL (PRESSURIZED)	IF NOTHING ELSE IS AVAILABLE, THESE EXTINGUISHERS MAY HAVE SOME EFFECT ON CLASS "A" FIRES	BICARBONATE OF SODA PRESSURIZED NITROGEN	LIFT LEVER HOLD NOZZLE SQUEEZE HANDLE	
CARBON DIOXIDE		CARBON DIOXIDE	PULL PIN SQUEEZE HANDLE	
FOAM	CLASS "A"- "B" FIRES (OIL, GASOLINE, PAINT, GREASE, ETC.)	WATER SOLUTION OR ALUMINUM SULFATE AND BICARBONATE OF SODA	OPEN VALVE ON HEAD AND TURN OVER	SMOTHERS BY BLANKETING ALSO COOLS

WATER EXTINGUISHERS
(PRESSURIZED)

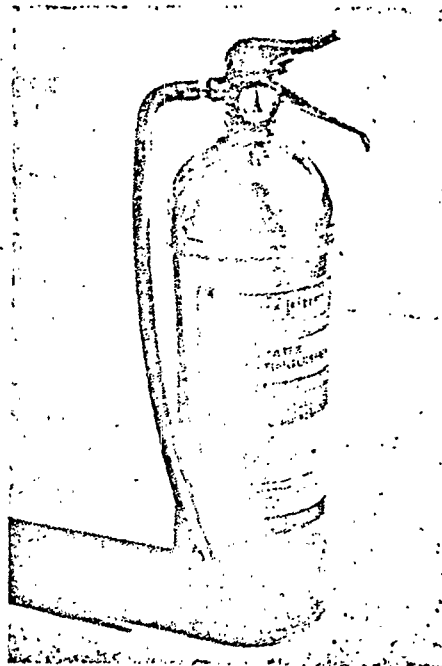
TO OPERATE :

1. KEEP IN UPRIGHT POSITION.
2. PULL LOCKING PIN.
3. SQUEEZE HANDLE TO RELEASE WATER.
4. DIRECT WATER AT BASE OF FLAME.
5. GET EXTINGUISHER RECHARGED AS SOON
AS POSSIBLE.

EFFECTIVENESS

1. EFFECTIVE ON SMALL FIRES IN WOOD,
PAPER, TEXTILES, AND RUBBISH,
2. MAY BE USED TO COOL HOT WOOD OR METAL.
3. IS NOT EFFECTIVE ON PETROLEUM TYPE FIRES..

NOTE: CONDUCTS ELECTRICITY - DANGEROUS TO
USE ON LIVE ELECTRICAL EQUIPMENT..



THE EFFECTIVENESS OF WATER LIES IN ITS ABILITY TO COOL AND TO PENETRATE. THUS TO COOL A FIRE, SOME SUBSTANCE MUST BE PROVIDED WHICH WILL ABSORB HEAT TO BRING THE BURNING MATERIAL TO A POINT BELOW ITS IGNITION TEMPERATURE. THIS WILL EXTINGUISH THE FIRE. WATER, WHICH IS A GOOD HEAT ABSORBER, IS MOST COMMONLY USED FOR THIS PURPOSE. IF COOLING TO PREVENT RE-IGNITION IS NECESSARY. WATER CAN BE USED VERY EFFECTIVELY (ON NON-ELECTRICAL FIRES) IN CONJUNCTION WITH CO₂ OR DRY CHEMICAL.

DRY CHEMICAL EXTINGUISHERS

THE EFFECTIVENESS OF DRY CHEMICAL IS IN ITS ABILITY TO INTERRUPT THE CHAIN-REACTION OF OXIDATION AND NEARLY INSTANTLY SUPPRESS FLAME. A CLOUD OF DRY CHEMICAL IS SIMILAR TO A FLAME ARRESTOR IN THAT A FLAME CANNOT PASS THROUGH A CLOUD OF PARTICLES WHEN IN PROPER CONCENTRATION, AND CONVERSELY WHEN A CLOUD OF PARTICLES IS PRODUCED WHERE THE COMBUSTION REACTION IS PROCEEDING, EXTINGUISHMENT TAKES PLACE.

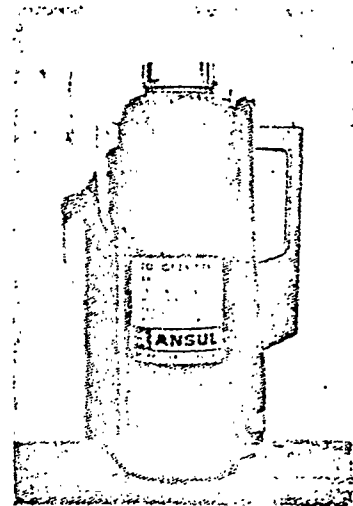
TO OPERATE:

CARTRIDGE TYPE:

1. REMOVE HOSE AND PUSH ON LEVER TO PUNCTURE CO₂ CARTRIDGE.
2. SQUEEZE HANDLE ON HOSE NOZZLE TO RELEASE POWDER.
3. DIRECT POWDER AT BASE OF FLAMES WITH SIDE-TO-SIDE MOTION.
4. GET EXTINGUISHER RECHARGED AS SOON AS POSSIBLE.



PRESSURIZED
TYPE



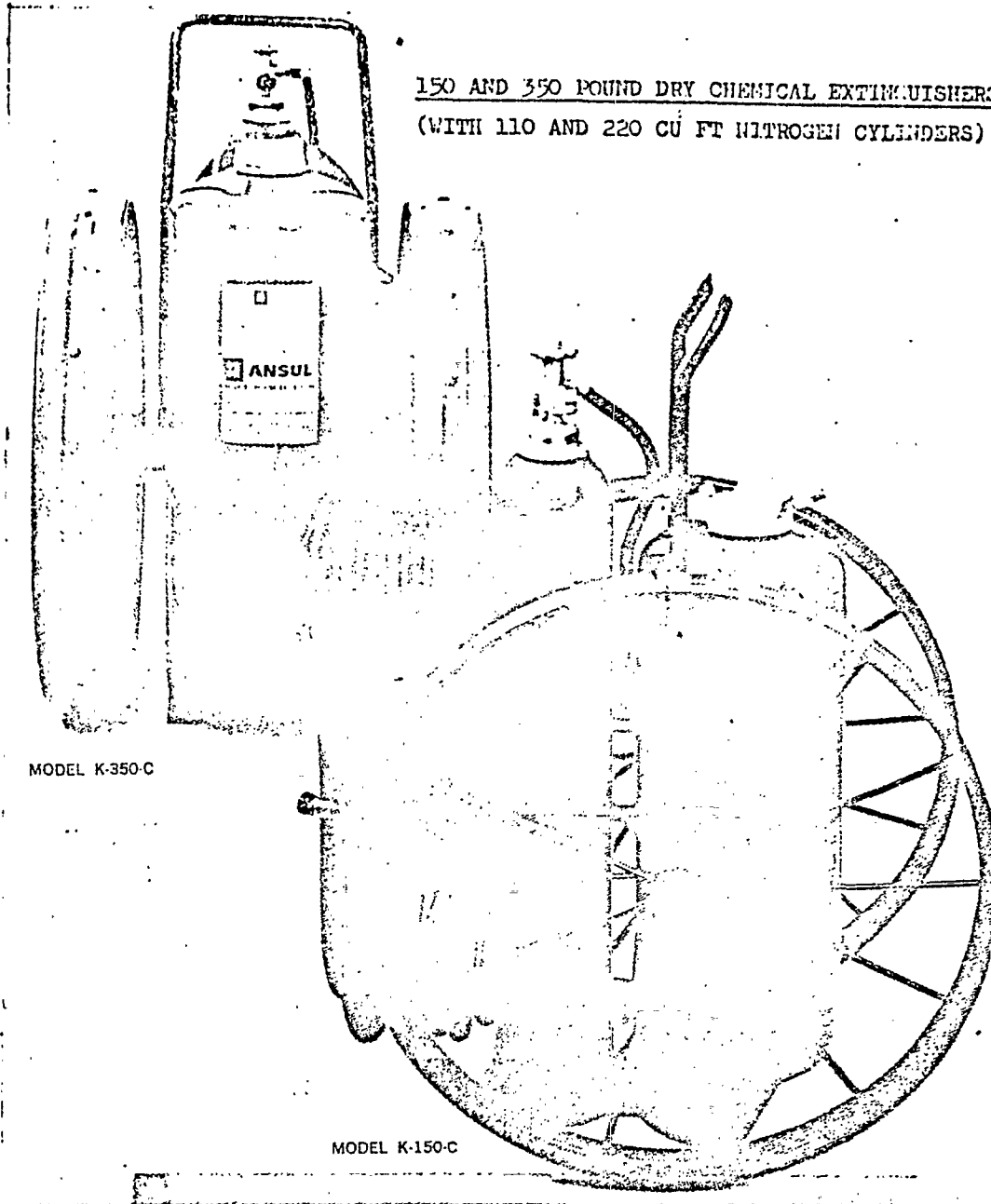
CARTRIDGE TYPE

PRESSURIZED TYPE:

1. LIFT LOCKING LEVER.
2. SQUEEZE HANDLE TO RELEASE POWDER.
3. DIRECT POWDER AT BASE OF FLAMES WITH SIDE-TO-SIDE MOTION.
4. GET EXTINGUISHER RECHARGED AS SOON AS POSSIBLE.

NOTE: WHEN OPERATING, KEEP BOTH TYPES OF DRY CHEMICAL EXTINGUISHERS IN AN UPRIGHT POSITION.

150 AND 350 POUND DRY CHEMICAL EXTINGUISHERS
(WITH 110 AND 220 CU FT NITROGEN CYLINDERS)



TO OPERATE:

1. KEEP EXTINGUISHER UPRIGHT.
2. OPEN CYLINDER VALVE.
3. PULL OUT HOSE AND OPEN NOZZLE.
4. DIRECT STREAM AT BASE OF FLAME WITH A SIDE-TO-SIDE MOTION.
5. GET EXTINGUISHER RECHARGED AS SOON AS POSSIBLE.

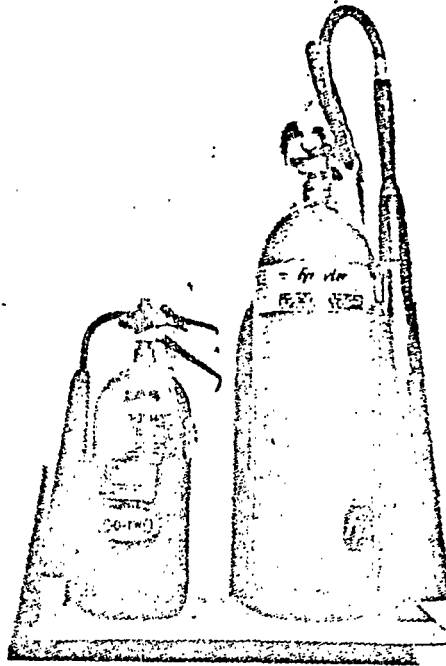
CARBON DIOXIDE EXTINGUISHERS

TO OPERATE:

1. PULL PIN.
2. SQUEEZE HANDLE TO RELEASE GAS.
3. DIRECT GAS AT BASE OF FLAME (RANGE IS VERY LIMITED, SO DISCHARGE MUST BE CLOSE TO FLAME).
4. GET EXTINGUISHER RECHARGED AS SOON AS POSSIBLE.

EFFECTIVENESS:

1. ALL TYPES OF HYDROCARBON FIRES.
2. EXCELLENT EXTINGUISHER FOR ELECTRICAL FIRES (IS A NON-CONDUCTOR OF ELECTRICITY).
3. LEAST EFFECTIVE ON WOOD, PAPER, ETC.



THE EFFECTIVENESS OF CARBON DIOXIDE LIES IN ITS ABILITY TO BLANKET A FIRE WITH A NON-COMBUSTABLE ATMOSPHERE, AND THUS SMOOTHER THE FIRE BY EXCLUSION OF THE OXYGEN REQUIRED FOR COMBUSTION. IT ALSO HAS SOME COOLING EFFECT, BUT THIS IS OF MINOR IMPORTANCE. IF COOLING TO PREVENT RE-IGNITION IS NECESSARY, WATER SHOULD BE USED IN CONJUNCTION WITH CO₂. WATER AND CO₂ WORK VERY WELL TOGETHER.

THIS GAS IS DRY, CLEAN, AND HARMLESS TO EQUIPMENT AND UNEBURNED MATERIALS, THUS LIMITING DAMAGE TO THAT DONE BY THE FIRE ITSELF. CARBON DIOXIDE GAS WILL NOT CONDUCT ELECTRICITY. IT IS THEREFORE IDEALLY SUITED FOR USE AROUND EQUIPMENT IN CONGESTED AREAS OR ELECTRICAL EQUIPMENT.

OPERATIONS

CHEV B8 6497

CHEV B8 6498

CONFIDENTIAL

PREFRACTIONATOR SYSTEM - PU-1342

Section III-A

Purpose:

The Prefractionator is used to prepare Hydrobon Reactor charge from the straight run gasoline which is charged to the unit. Desirable charge should contain a minimum of pentane and lighter. The lighter material is not harmful to the process, but does take up unit capacity which is more profitably used to reform the heavier gasoline fraction. Also, the prefractionator will remove overhead any hydrogen sulfide (H_2S), oxygen, water and ammonia which may be in the straight run gasoline charged to the unit.

Operation:

Straight run gasoline from various crude still depentanizers is charged to PU 1342 from either tank No. 2588 or No. 2590. Pump House No. 163, Bulk Oil Department, maintains the charge tank inventory. The straight run gasoline charge is picked up at PU 1342 by P-400A Prefractionator Charge Pump (Spared by P-400B) and sent through the charge filters PV-409, 410, and 411 in parallel flow. The charge filter elements are made of paper which will filter out any particles greater than 5 microns (0.0013 inches) in diameter. Over a period of time, due to the build up of particles on the paper elements, a pressure drop is created across the filters. When this pressure drop approaches 15 pounds per square inch (i.e. 15 psi), the charge filters are by-passed, steamed out and washed with water, and new elements are installed (11 double elements/filter).

After the charge filters, the straight run gasoline is split into two streams. Each stream passes through a charge regulator (FRC-277 or FRC-278) which is set to maintain the desirable charge rate to the Prefractionator tower. After the charge regulators, each stream is sent through the shell side of an exchanger (E-400A or E-400B) where the Prefractionator charge (straight run gasoline) gains heat liberated by the Platformer Reactor effluent stream flowing through the tube side of the exchangers.

Following the preheat exchangers, the streams combine and the single stream is charged normally to the 16th tray of the Prefractionator Tower. An alternate inlet on the 27th tray is normally not used. The Prefractionator Tower is a distillation column in which lighter fractions of the unit charge

PREFRACTIONATOR SYSTEM-PU 1342 Section III-A - Continued

are "boiled" overhead through the addition of heat. Heat is added to the bottom of the Prefractionator Tower by means of a "reboiler circuit" which passes through two fired furnaces. The reboiler circuit begins at a draw off on the bottom of the Prefractionator tower. This draw off provides the suction to the Prefractionator Reboiler pump P-2A (Spared by P-2B). After the discharge of P-2A, the reboiler circuit splits into two streams. One stream goes through the vertical Prefractionator Reboiler Heater, PH-602. This stream splits into four passes before PH-602. The flow in each pass is controlled by either FRC-640, FRC-639, FRC-638 or FRC-31. This reboiler heater has four burners with pilots. The amount of firing gas to these burners is controlled by the level (LR-14) in the Prefractionator Tower. Firing gas control valve, FRC-30, is automatically reset to provide more gas, thus more heat, as the level in the Prefractionator Tower rises, or less gas as the tower level falls.

The other stream in the reboiler circuit is sent through the upper portion (convection section) of PH-400 heater to recover heat which would otherwise be wasted out through the stacks. There are four passes through the convection section of PH-400 heater. Each pass has a flow control valve (FRC-151, FRC-152, FRC-153 or FRC-154) to maintain a constant and evenly distributed flow through the convection section. The hot streams coming from the convection section of PH-400 and from PH-602 are combined and sent to the flash section (space between bottom tray and bottom of tower) of the Prefractionator Tower. The lighter fractions will go up the tower and come out in the overhead stream.

The overhead vapor stream is sent through four water condensers E-1A-1&2 and E-1B-1&2 to condense these vapors. After the condensers, the overhead stream goes to the Prefractionator Reflux Accumulator, PV-2. That lighter portion which does not condense, (oxygen, H₂S and some water vapor) can be taken off as a gas from the top of the accumulator through PRC-38 control valve. This wet gas is sent to the gas plant GCU 7944. In this operation the amount of gas being vented through PRC-38 controls the pressure on the top of the Prefractionator Tower. The liquid in the accumulator is used as reflux, pumped by P-1A (spared by P-1B), to the top of the Prefractionator Reflux, controlled by FRC-49, is used to control the top temperature on the tower and also as an absorption oil flowing down the tower to keep heavier fractions in the bottom of the tower. The liquid which is not used as reflux from the accumulator is sent out as Prefractionator overhead product, pumped by P-10A (spared by P-10B), to Benzene unit charge or to the Gasoline Treating

PREFRACTIONATOR SYSTEM-FU 1342 Section III-A - Continued

Plant at 97 Pump House. The amount of Prefractionator overhead product is reset by a level controller which maintains a set level in the accumulator. If the level starts rising, the level controller opens control valve FRC-52 so that more overhead product will leave the accumulator, and closes the control valve if the level starts falling.

An alternate operation on the Prefractionator Reflux Accumulator is to run with a liquid full, or "flooded", accumulator. In this operation the pressure control is switched from PRC-38 to FRC-52. The liquid which is not used as reflux is still sent out as Prefractionator overhead product through FRC-52. However, with the level controller taken out of service, and a liquid full receiver, as the pressure on the Prefractionator Tower increases, the pressure controller will open FRC-52 to allow more overhead product to be pulled thus lowering the pressure back to normal. In this operation the lighter non-condensing-fractions will remain in solution and eventually go out with Prefractionator overhead product.

The Prefractionator bottoms that are not used in the reboiler circuit is the stream which will eventually be charged to the Platformer Reactors. However, this stream contains some compounds which would be harmful to the Platformer Reactor catalyst. For this reason, the Prefractionator bottoms are pumped with P-3 (spared by P-8B) through a Hydrobon Reactor system which is covered in the next section of this manual.

Miscellaneous:

1. Because of corrosion problems in the Prefractionator overhead condensers (E-1A-1&2 and E-1B-1&2), we use two methods of insuring minimum corrosion effects. First, there is a continuous injection of a corrosion inhibitor, Cronox-601, into the Prefractionator Overhead stream before the overhead condensers. This inhibitor greatly reduces the deposit of corrosion promoting compounds on the tubes of the condensers. A second method of preventing corrosive compounds from building up concentrations is to periodically water wash the shell side of the condensers by injecting water, with P-4 pump, into the overhead stream ahead of the condensers. This water settles out in the overhead accumulator water-boot and is drawn to the sewer.
2. During start-up and in the event of an emergency, the Prefractionator bottoms stream can be directed straight to the field back to the unit

PREFRACTIONATOR SYSTEM-PU 1342 Section IIIA - Continued

charge tank. This is done through FRC-3 control valve and by lining up back to the tank at the product manifold. The stream will be cooled by the E-3A&B coolers ahead of FRC-3 before being sent to the charge tank.

3. The start-up circulation system flow is controlled by MCV-1 (Manual Control Valve) on the circulation stream flowing to the Prefractionator Overhead Accumulator. The entire start-up system is covered in a separate section.
4. When running the Prefractionator Tower with a wet gas product stream controlling the tower pressure, there are times when there is not enough light gas in the Prefractionator charge to maintain the tower pressure. During this operation, therefore, a small amount of natural gas is added to the Prefractionator O.H. Accumulator to aid in giving good control on the tower pressure.

RWL:mkw:10-8-75

PU 1342

Sample Questions

PREFRACTIONATOR SYSTEM

1. Where does charge come into unit?
2. What pump picks up the unit charge? *P460A Prefractionator chg. pump*
3. Where is pressure transmitter on suction to the charge pump?
4. What does a change in the suction pressure to the charge pump indicate?
5. What pump is the spare to the charge pump? *P460B*
6. What happens if both suction valves to the spare charge pump are open or leaking?
7. How do you by-pass the charge filters?
8. How do you pumpout the charge filters?
9. How do you wash the charge filters?
10. How do you put charge filters back in service?
11. What does differential pressure across the charge filters indicate?
12. Where is differential pressure gage located?
13. When should charge filter be by-passed?
14. Why and where is charge to prefractionator split?
15. Where are control valves for charge to prefractionator?
16. Where are flow indicators (D/P cells and orifices) for prefractionator charge located?
17. When and why do you vary flow to prefractionator?
18. Where and what product heats charge to prefractionator?
19. Where does charge enter prefractionator?
20. Is there a check valve in prefractionator charge line? *No*
21. Where is gas added to prefractionator?
22. Why is gas added to prefractionator?
23. When do you vary amount of gas to prefractionator?
24. How is pressure controlled on prefractionator?
25. Do you add an inhibitor to prefractionator overhead? If so, what is the inhibitor and how is it added.
26. Where are the overhead condensers for the prefractionator?
27. How do you know if prefractionator overhead condensers are leaking.

FU 1342 PREFRACTIONATOR

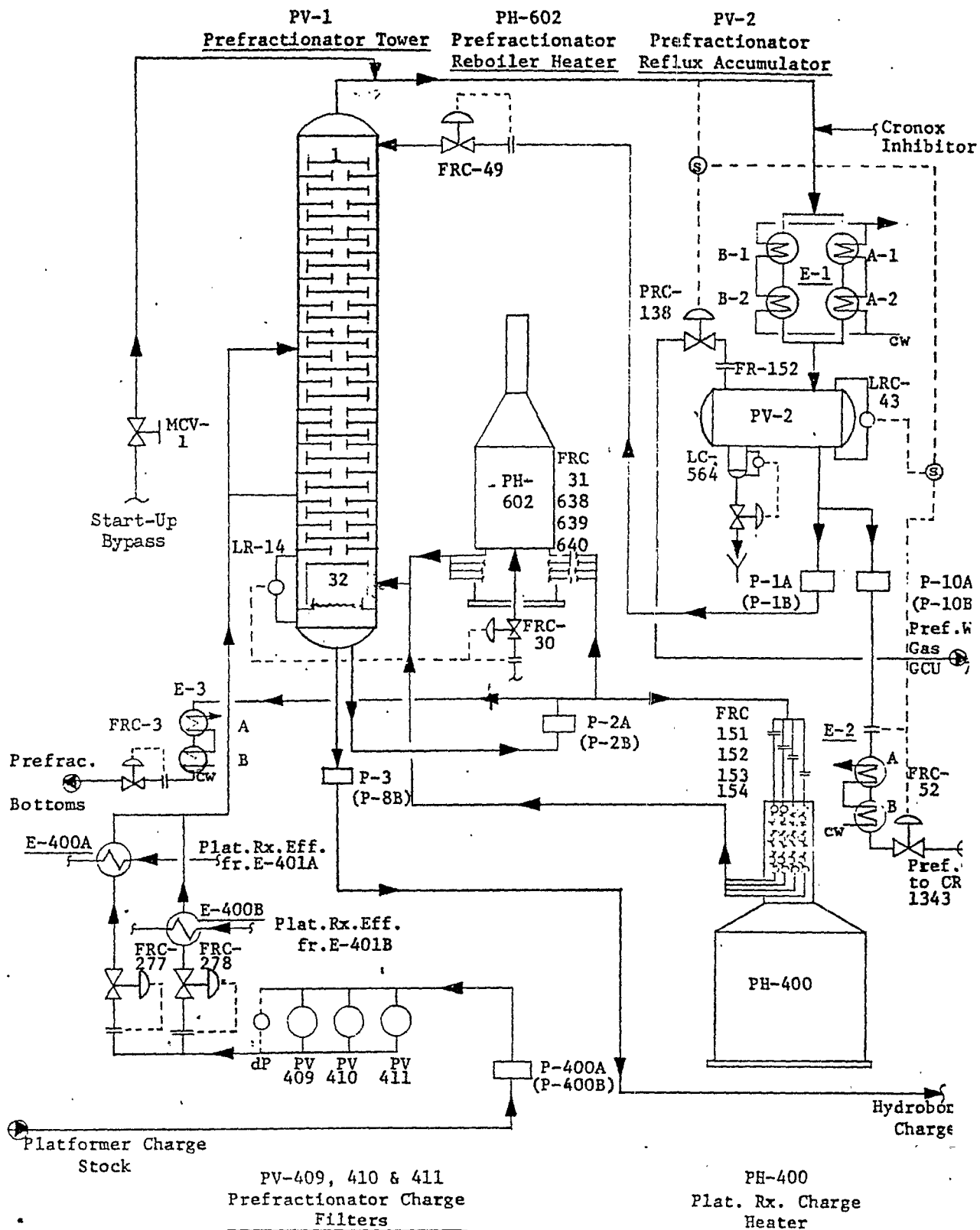
28. Where is prefractionator reflux accumulator (Overhead Receiver)?
29. How do you draw water from receiver?
30. How do you wash prefractionator overhead condensers?
31. Where is prefractionator reflux pump?
32. Where is reflux regulator and flow meter?
33. How do you control reflux rate to prefractionator?
34. How do you control level in reflux accumulator?
35. How do you check level in reflux accumulator?
36. What is normal level in reflux accumulator?
37. Where is control valve and flow meter for prefractionator liquid overhead product?
38. Where is liquid overhead from prefractionator pumped to?
39. What pump pumps liquid overhead product?
40. Where is overhead pump located?
41. Where does overhead gas go?
42. Where are overhead gas meter and flow control?
43. What pressure do we normally maintain on the prefractionator?
44. Where are safeties located on prefractionator? How many?
45. What pressure do the safeties pop on the prefractionator?
46. How is heat put into tower?
47. How is level controlled in bottom of tower?
48. What controls gas flow to prefractionator reboiler heater (PH-602)?
49. Where is control valve and flow meter for prefractionator reboiler heater?
50. How many passes on prefractionator reboiler heater? 4
51. Where are control valves and flow meters for reboiler heater located?
52. What other heater (besides PH-602) supplies heat for prefractionator?
53. How many passes in convection section of PH-400 heater?
54. Where are control valves and flow meters for PH-400 heater convection section?
55. What is meant by convection section?
56. What pump circulates oil thru the heater? p-2 A

PU 1342 PREFRACTIONATOR

57. Where does reboiler circulation return to the tower?
58. Is there a check valve at the tower on reboiler circulation?
59. What pump other than the reboiler pump takes suction from the prefractionator bottoms? Where is this oil pumped?
60. What pump spares prefractionator reboiler pump (P-2A)?
61. What happens if both suction valves are open to P-2B pump?
62. What pump spares hydrobon charge pump P-3?
63. What happens if both suction valves are open to P-8B?
64. When do we take some prefractionator bottoms directly to the field?
65. Where are control valve and flow meter on prefractionator bottoms?
66. How can you tell if prefractionator bottoms cooler is leaking?
67. How do you maintain temperature on tower? Where are the temperature sensing points? When do you change the overhead temperature?
68. How much reflux do we add to tower? When would you change amount of reflux?
69. What level can control amount of liquid overhead we produce?
70. What controls amount of liquid bottoms we produce?
71. When do we put some prefractionator bottoms to charge tank? How do we control this amount?
72. What alarms are on this tower and its overhead receiver? When do you check these alarms? How do you check these alarms?
73. What happens if you get a vacuum on this tower? How can you prevent a vacuum?
74. How is prefractionator tower pressure controlled using "flooded" overhead accumulator?

RWL:mkw:10-14-75

PU-1342
PREFRACTIONATOR SYSTEM



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HYPERON

HYDROBON SYSTEM

Section III - B

The Hydrobon Section is designed to treat low quality straight run gasoline for production of superior quality platforming charge stock. The Hydrobon Process is a fixed bed hydrogenation process employing UOP S-6 catalyst and a hydrogen rich recycle stream. In the Hydrobon Reactor, a mixture of recycle gas and prefractionator bottoms is passed over the catalyst. Here contaminants such as sulfur and nitrogen are converted to the easily removed forms of hydrogen sulfide and ammonia. Also, olefins are saturated and oxygen compounds decomposed.

X The prefractionator bottoms picks up heat from the Hydrobon Reactor effluent in the E-5 heat exchangers. The preheated bottoms then goes through the four passes of Hydrobon Charge Heater PH-1, then through the four passes of Hydrobon Charger Heater PH-2. Approximately one half of the hydrogen rich recycle stream is split before E-4 heat exchanger. One half mixes with the prefractionator bottoms after FRC-76 and before the E-5 heat exchangers. The other half picks up heat from the Hydrobon Reactor effluent in E-4 heat exchanger before it mixes with the Hydrobon Reactor charge from PH-2 Heater. Splitting the hydrogen allows the heater not to be fired as hard. This mixed stream then enters the top of the Hydrobon Reactor PV-3.

The reaction in the Hydrobon Reactor is usually slightly endothermic; that is, it consumes heat. This is shown by a small temperature decrease from the inlet reactor temperature to outlet reactor temperature.

After the reactor, the effluent first gives up heat to the hydrogen recycle stream in E-4 heat exchanger, then to the Hydrobon Reactor charge in the E-5 heat exchanger and finally to the Hydrobon Stripper charge in the E-6 heat exchangers. The effluent is then further cooled with cooling tower water in the E-7 effluent condensers.

The cooled reactor effluent is then separated into a gas stream rich in hydrogen and a liquid stream in PV-4 Hydrobon Products Separator. The gas stream goes to other process units via booster compressors C-401 and C-500 A, B, and C. The liquid stream is pressured to PV-5 Hydrobon Flash Drum, where hydrogen and other light ends (methane, ethane, etc.) are flashed off and sent to fuel. The liquid off the Flash Drum is pumped by P-5 pump through E-6 heat exchangers where it picks up heat from the Hydrobon Reactor effluent, then to PV-6 Hydrobon Stripper Tower.

(2)

In the Stripper, the hydrogen sulfide and ammonia are stripped out of the heavier oil and carried overhead along with light hydrocarbons as a vapor. The heavier fractions in the overhead vapor are condensed in E-8 condensers, accumulated in PV-7 Hydrobon Stripper Reflux Accumulator and pumped back to the tower as reflux by P-6 pump. The non-condensed gasses (hydrogen sulfide, ammonia and light hydrocarbons) are sent to the gas plant. Pump P-7 takes suction on the bottom of PV-6 and pumps the oil through the four passes of PH-3 Hydrobon Stripper Reboiler Heater, where approximately 50% of the oil is vaporized and returned to the bottom section of the tower. Also taking suction at the bottom of the tower is pump P-8, which pumps stripper bottoms to Platformer Reactor Charge. This charge should contain less than one (1) ppm sulfur and one (1) ppm nitrogen.

The results from the Hydrobon System are a much more suitable charge stock for the subsequent platforming operation with little or no volume yield loss.

The following is the control instrumentation used in Hydrobon Section:

- 1) Platformer Charge - controlled FRC's 250, 251, 259, and 260. FRC's 258 and 556 can be used to by-pass platformer charge around the effluent exchangers E-402A and E-402B. The quantity of oil charged to the Platformer is determined by the quantity of straight run gasoline stock available to the unit. The total Platformer Reactor charge is recorded on FR-671. This flow will remain constant until orders are given to raise or lower Platformer Reactor Charge. When the charge is raised or lowered, an equal amount should be raised or lowered on FRC's 250, 251, 259, and 260.
- 2) Hydrobon Charge - controlled by FRC-76. The quantity of oil charged to the Hydrobon is directly related to the amount of oil charged to the Platformer. If Platformer Charge is raised, a proportional amount of Hydrobon Charge is raised. This instrument is also used to hold the level in PV-6 Hydrobon Stripper. When the level begins to fall in the Stripper, the pen on FRC-76 is raised slightly and vice versa.
- 3) Hydrobon Reactor Inlet Temperature - controlled by TRC-62 working in cascade with FRC-61, fuel gas to PH-2 Hydrobon Charge Heater. To raise the reactor inlet temperature, the pointer on TRC-62 is raised. The fuel gas to the heater is therefore increased through FRC-61 regulator.
- 4) Fuel Gas to PH-1 Hydrobon Charge Heater - controlled by FRC-415. This flow usually remains constant. The flow is set to balance the heat load between PH-1 and PH-2.

(3)

- 5) Hydrobon Products Separator Pressure - controlled by PRC-97, which senses and records the pressure of the separator. If the pressure is below the set point, an air signal is sent to the regulator to close, allowing less gas to the Booster Compressor System. FR-98 records the gas flow from the separator.
- 6) Hydrobon Products Separator Level - controlled by LRC-100 working in cascade with FRC-101 liquid to Hydrobon Flash Drum. The level is set by the instrument man. LRC-100 sends an air signal to FRC-101 to either increase or decrease as needed the flow of liquid from the Separator to the Flash Drum.
- 7) Hydrobon Flash Drum Pressure - controlled by PRC-103, which senses and records the pressure of the Flash Drum. If the pressure is above the set point, an air signal is sent to the regulator to open allowing more gas to the Product Gas Drum. FR-104 records the gas flow from the separator.
- 8) Hydrobon Flash Drum Level - controlled LRC-106 working in cascade with FRC-110, Hydrobon Stripper Charge. The level is set by the instrument man. LRC-106 sends an air signal to FRC-110 to either increase or decrease as needed the flow of liquid from the Flash Drum to the Stripper.
- 9) Emergency By-Pass Around Hydrobon Flash Drum - it is actuated by a high level in the Flash Drum. It protects the Platformer Reactor Charge Pump P-8A from losing suction due to a low level in the Hydrobon Stripper. If pump P-5, Stripper Charge Pump were to kick off, the level could be lost in the Hydrobon Stripper before the pump could be put back in service due to the Hydrobon Stripper being a small tower. Since the Hydrobon Products Separator operates at a higher pressure than the Hydrobon Stripper, the liquid from the Hydrobon Products Separator can be by-passed around the Flash Drum and pressured directly to the stripper. When a high level exists, an electrical signal is automatically sent to the by-pass regulator for it to open and for FRC-110 to close. LRC-100 then controls the amount of charge to the stripper.
- 10) Hydrobon Stripper Receiver Level - controlled by LRC-137 working in cascade with FRC-129, Hydrobon Stripper Reflux, to hold a preset level. The Hydrobon Stripper operates with total reflux; that is, all the liquid accumulated in the receiver is returned to the tower as reflux. The LRC sends an air signal to FRC-129 to either increase or decrease as needed the flow of reflux.

(4) .

- 11) Hydrobon Stripper Reflux - the amount of reflux should be held at 3.5 - 4.0 divisions on FRC-129. To increase or decrease this quantity, FRC-128, fuel gas to PH-3 heater is varied. To increase the amount of reflux, the amount of fuel gas to the heater is increased.
- 12) Hydrobon Stripper Pressure - controlled by PRC-135. The pressure is controlled by regulating the amount of Stripper Gas going to the Gas Plant. When the pressure begins to build, more gas is let off the Hydrobon Stripper Reflux Accumulator and vice versa. The amount of gas leaving is recorded by FR-134.
- 13) Cronox 601 Injection - Because of corrosion problems in the Stripper Overhead Condensers (E-8A&B), a continuous injection of Cronox 601 corrosion inhibitor is injected into the Stripper Overhead stream before the condensers. This inhibitor greatly reduces the deposit of corrosion promoting compounds on the tubes of the condensers. This inhibitor is injected from V-8 Corrosion Inhibitor Tank by P-9 Corrosion Inhibitor Injection Pump. To vary the amount injected the stroke of the pump is either shortened or lengthened.

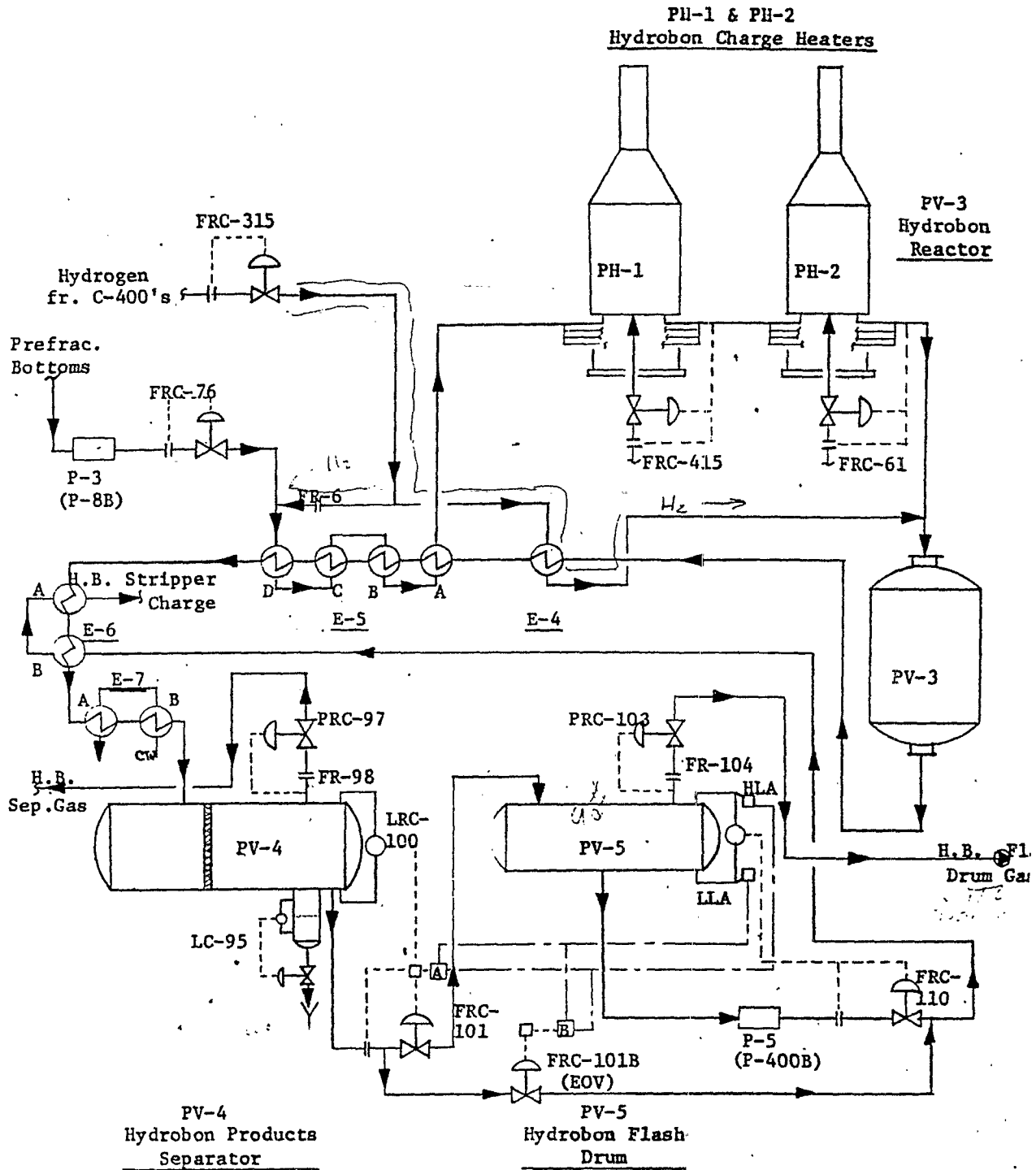
LTS:mkw:2-3-76

QUESTIONS - Hydrobon Section

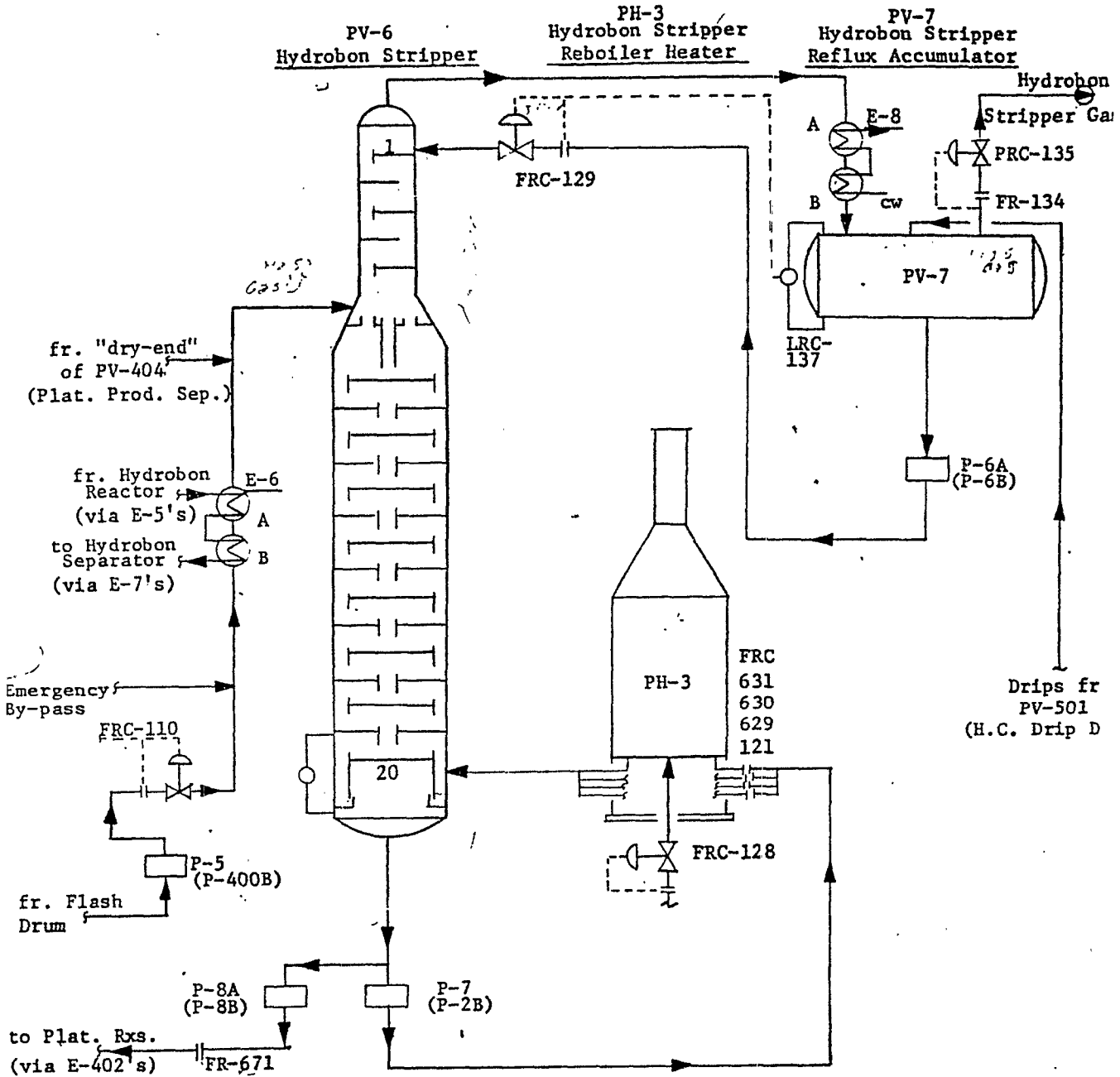
1. What is the purpose of the Hydrobon Reactor? How does it work?
2. What is the purpose of the Hydrobon Products Separator?
3. What is the purpose of the Hydrobon Flash Drum?
4. What is the purpose of the Hydrobon Stripper?
5. Which heater supplies heat to the Hydrobon Stripper? Where located?
6. Which heaters supply heat to the Hydrobon Reactor? Where located?
7. What is the maximum amount of sulfur allowed in Platformer Charge? Nitrogen?
8. What determines the amount of Platformer Charge?
9. What determines the amount of Hydrobon Charge?
10. How is the Hydrobon Stripper Level controlled?
11. How is the Hydrobon Reactor inlet temperature controlled?
12. How is the Hydrobon Products Separator pressure controlled?
13. How is the Hydrobon Products Separator level controlled?
14. How is the Hydrobon Flash Drum pressure controlled?
15. How is the Hydrobon Flash Drum level controlled?
16. What is the purpose of the emergency by-pass? How does it work?
17. How is the Hydrobon Stripper Receiver level controlled?
18. How is the Hydrobon Stripper reflux controlled? How much is needed?
19. How is the Hydrobon Stripper pressure controlled?
20. What is the normal distribution of the Hydrobon Products Separator?
21. What is the disposition of the Hydrobon Stripper Gas?
22. What is the disposition of the Hydrobon Flash Drum Gas?

LTS:cjm 1-28-76

PU-1342
HYDROBON REACTOR SYSTEM



PU-1342
HYDROBON STRIPPER SYSTEM



RWL
 10-13-75

PLATFORMING SECTION
SECTION III-C

The Platforming Section is a catalytic reforming process employing U O P R-11 catalyst and a hydrogen rich recycle stream to convert straight run gasoline into high octane motor fuel.

Four main reactions take place in the reactors: dehydrogenation or aromatization, hydrocracking, isomerization, and cyclization. Dehydrogenation removes hydrogen atoms from naphthenes to form aromatics. The reaction is endothermic, that is it consumes heat. It is a relatively fast reaction which results in a slight overall volume shrinkage. Large temperature drops across the first reactor; high hydrogen production per barrel of charge plus high hydrogen purity indicates good aromatization.

Hydrocracking consumes hydrogen in the breakup of a paraffin molecule into smaller paraffin molecules. The reaction is exothermic, that is, it creates heat. Decreasing temperature drop across the last reactor, increased Depropanizer and Debutanizer overhead production per barrel of reactor charge, decreased Debutanizer bottom product yield, or decreased separator gas hydrogen content, generally indicates an increase in the hydrocracking reaction. If the hydrocracking reaction becomes too severe an excessive amount of coke is deposited on the catalyst. When coke is deposited on the catalyst, higher reactor temperatures are required to obtain the same octane as before the coking, and the percent hydrogen in the recycle gas decreases.

The isomerization reaction is one in which the hydrocarbon formula remains the same but the shape of the hydrocarbon molecule changes. The reaction products are subject to further reaction to form aromatics and smaller paraffins. Isomerization reactions are mildly exothermic but the heat created is insignificant when compared to hydrocracking.

Cyclization converts paraffins into naphthenes with the production of some hydrogen. This reaction is endothermic. Dehydrogenation of the naphthenes to aromatics follows the cyclization reaction.

The Hydrobon Stripper bottoms splits into four passes with each pass being combined with the hydrogen rich recycle stream. The combined streams then pick up heat from the Platformer Reactor Effluent in E-402-A and E-402-B. After the combined stream exists the E-402's, water and propylene dichloride are injected. The water injection serves two purposes: (1) It washes away chloride to prevent an excessive amount of chloride buildup on the catalyst, and

It forms acid sites with the chloride on the catalyst which promote the reactions. The addition of chloride promotes the hydrocracking reaction, Too much chloride injection promotes an excessive amount of hydrocracking which tends to increase coke deposits on the catalyst.

The combined streams then enter the four passes of PH-400 Charge Heater where the oil is vaporized before entering the top of PV-400 Reactor. The majority of the hydrogenation occurs in this reactor. This is shown by a large temperature drop. The effluent from the first reactor enters the four passes of the number one coil of PH-401 Intermediate Heater before entering the top of PV-401 Reactor. The reaction in this reactor is also endothermic but to a lesser degree. The effluent from the second reactor enters the four passes of the number two coil of PH-401 Intermediate Heater before entering the top of PV-402 Reactor. In the third reactor the primary reaction is hydrocracking, but there is also enough dehydrogenation to make the total reaction slightly endothermic.

The effluent from the third reactor gives up heat to the reactor charge in the E-402's, then to the hydrogen rich recycle stream in the E-401's and finally to the Prefractionator charge in the E-400's. The reactor effluent is then cooled with cooling tower water in the E-403's.

In PV-404 Reactor Products Separator the cooled reactor effluent is separated into a liquid stream and a gas stream rich in hydrogen. The major portion of the gas stream is recycled back to the Platformer Reactors and to the Hydrobon Reactor by compressors C-400 A and B. Normally the liquid stream is pressured to PV-600 Depropanizer. During start-up and shutdown Depropanizer Charge Pump P-401 is put in service.

The following is the control instrumentation used on the Platforming Section.

- 1) First Reactor Inlet Temperature - Controlled by TRC-155, TRC-156, TRC-157 and TRC-158 working in cascade with FRC-186, FRC-185, FRC-188 and FRC-187 fuel gas to PH-400 Heater. These TRC's control the outlet temperatures of the four passes in PH-400 Heater. To raise the inlet temperature, the pens on each of these instruments are raised an equal amount. An air signal is then sent to the FRC's to open allowing a greater amount of fuel gas to be burned in the heater; thus, the reactor inlet temperature is raised.
- 2) Second Reactor Inlet Temperature - Controlled by TRC-218 working in cascade with FRC-232 fuel gas to coil 1 of PH-401 Heater. To raise the inlet temperature th

PLATFORMING SECTION-Continued

- pen on this TRC is raised. An air signal is then sent to the FRC to open allowing a greater amount of fuel gas to be burned in the heater; thus, the reactor inlet temperature is raised.
- 3) Third Reactor Inlet Temperature - Controlled by TRC-220 working in cascade with FRC-233 fuel gas to coil 2 of PH-401 Heater. To raise the inlet temperature, the pen on this instrument is raised. An air signal is then sent to the FRC to open allowing a greater amount of fuel gas to be burned in the heater; thus, the reactor inlet temperature is raised.
 - 4) Chloride Injection - Raised or lowered by adjusting the stroke on the North end of P-404 pump.
 - 5) Water Injection - Raised or lowered by adjusting the stroke on the South end of P-404 pump.
 - 6) Pentanes from PU 1343 - This quantity is controlled by PU 1343. It is recorded at PU 1342 by FR-205.
 - 7) Recycle Hydrogen to Platformer Reactors - Controlled by the speed of compressors C-400A and C-400B. To increase the flow, the compressors' speeds are increased. This quantity is recorded by FR-273.
 - 8) Reactor Products Separator Level - Controlled by LRC-295 working in cascade with FRC-300, separator liquid to Depropanizer PV-600. LRC-295 holds a preset level by sending an air signal to FRC-300 to either increase or decrease as needed the flow of liquid from the separator.
 - 9) Reactor Separator Pressure - Controlled by PRC-298. This PRC regulates the amount of hydrogen going to PV-500 Hydrogen Filters. When the pressure is low, less hydrogen leaves the separator and vice versa. This flow is recorded on FR-299.

LTS:oj:4-2-76

PLATFORMING SECTION

1. What is the purpose of the Platforming Section?
2. What catalyst is used?
3. What is an endothermic reaction?
4. What is an exothermic reaction?
5. Which type reaction is dehydrogenation?
6. Which type reaction is hydrocracking?
7. What are the characteristics of dehydrogenation?
8. What are the characteristics of hydrocracking?
9. What can happen if the hydrocracking reaction becomes too severe?
10. What effect does coke deposited on the catalyst have on the operation of the unit?
11. What is the purpose of water injection? How is it controlled?
12. What is the purpose of chloride injection? How is it controlled?
13. Which heater supplies heat to No. 1 Reactor? Where is it located?
14. Which heater supplies heat to No. 2 Reactor? Where is it located?
15. Which heater supplies heat to No. 3 Reactor? Where is it located?
16. What is the purpose of the Reactor Products Separator? Where is it located?
17. How are the reactor inlet temperatures controlled on No. 1 Reactor?
No. 2 Reactor? No. 3 Reactor?
18. How is the Reactor Products Separator pressure controlled?
19. How is the level in the Reactor Products Separator controlled?
20. How is the quantity of recycle hydrogen to Platformer Reactors controlled?

LTS:oj:4-2-76

PU-1342



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DEPROPANIZER PV-600

The purpose of the Depropanizer is to remove overhead the propane and lighter gases from the catalytic reformat charge from PV-404 Reactor Products Separator.

Reboiling heat is supplied by convection section coils of PH-401 heater, plus vertical tube Depropanizer Reboiler, PH-600. Heater PH-600 is exclusively in Depropanizer reboiler service and furnishes the trim heating for control of the 27th tray temperature.

The Depropanizer bottoms are partially cooled by cold feed to the Depropanizer in the E-600 exchangers and pressured to PV-604 Debutanizer as feed.

Vapors from the tower overhead are condensed in the E-601 condensers. The net propane and light gas stream are separated from the reflux liquid in PV-601 Depropanizer Receiver. The Depropanizer operates with total reflux; that is, all the liquid accumulated in the receiver is returned to the tower by pump P-603. The net overhead is a gas and is normally sent to the Ethylene Units as charge stock, but it can also be routed to fuel. To be suitable for Ethylene Unit charge, the 5% point of the boilaway should be between -25°F and -15°F.

The following is the control instrumentation used on the Depropanizer Tower:

- 1) Depropanizer Level - Controlled by LRC-337 working in cascade with FRC-342, Depropanizer Bottoms to Debutanizer. This instrument works automatically to hold a preset level. An air signal is sent from LRC-337 to FRC-342 to increase or decrease as needed the amount of Depropanizer bottoms to Debutanizer Feed.
- 2) Depropanizer Receiver Level - Controlled by LC-353. LC-353 controls the regulator on the hot vapor by-pass line around the E-601 overhead condensers. To increase the level in the receiver LC-353 sends an air signal to the regulator to close. As a result of this a greater amount of vapor is sent through the E-601 overhead condensers where it is condensed to a liquid; thus the receiver level increases.

DEPROPANIZER PV-600 - Continued

- 3) Depropanizer Overhead Temperature - Controlled by TRC-600 working in cascade with FRC-323, fuel gas to PH-600. To raise the overhead temperature, the pen on TRC-600 is raised. An air signal is then sent to FRC-323 to open, allowing a greater amount of fuel gas to be burned in PH-600 heater. As the temperature in the bottom of the tower increases, hotter vapors go overhead; thus, the overhead temperature is raised.
- 4) Depropanizer Reflux - Controlled by FRC-354. To raise or lower the amount of reflux, the pen on FRC-354 is raised or lowered. This flow, though, usually remains constant.
- 5) Reboiler Flow - Flow to PH-600 controlled by FRC's-322, 654, 655, and 656. Flow to PH-401 controlled by FRC's 196, 197, 198 and 199. Pump P-600 takes suction on the bottom of the tower and pumps the oil through the convection section of PH-401 and through the vertical tube reboiler which operate in parallel. These flows remain constant.
- 6) Depropanizer Pressure - Controlled by PRC-344 propane to the field. PRC-344 sends a signal to a regulator on the propane product to open when the pressure is high and close when the pressure is low. This flow is recorded on FR-343.

LTS:mkw:6-15-76

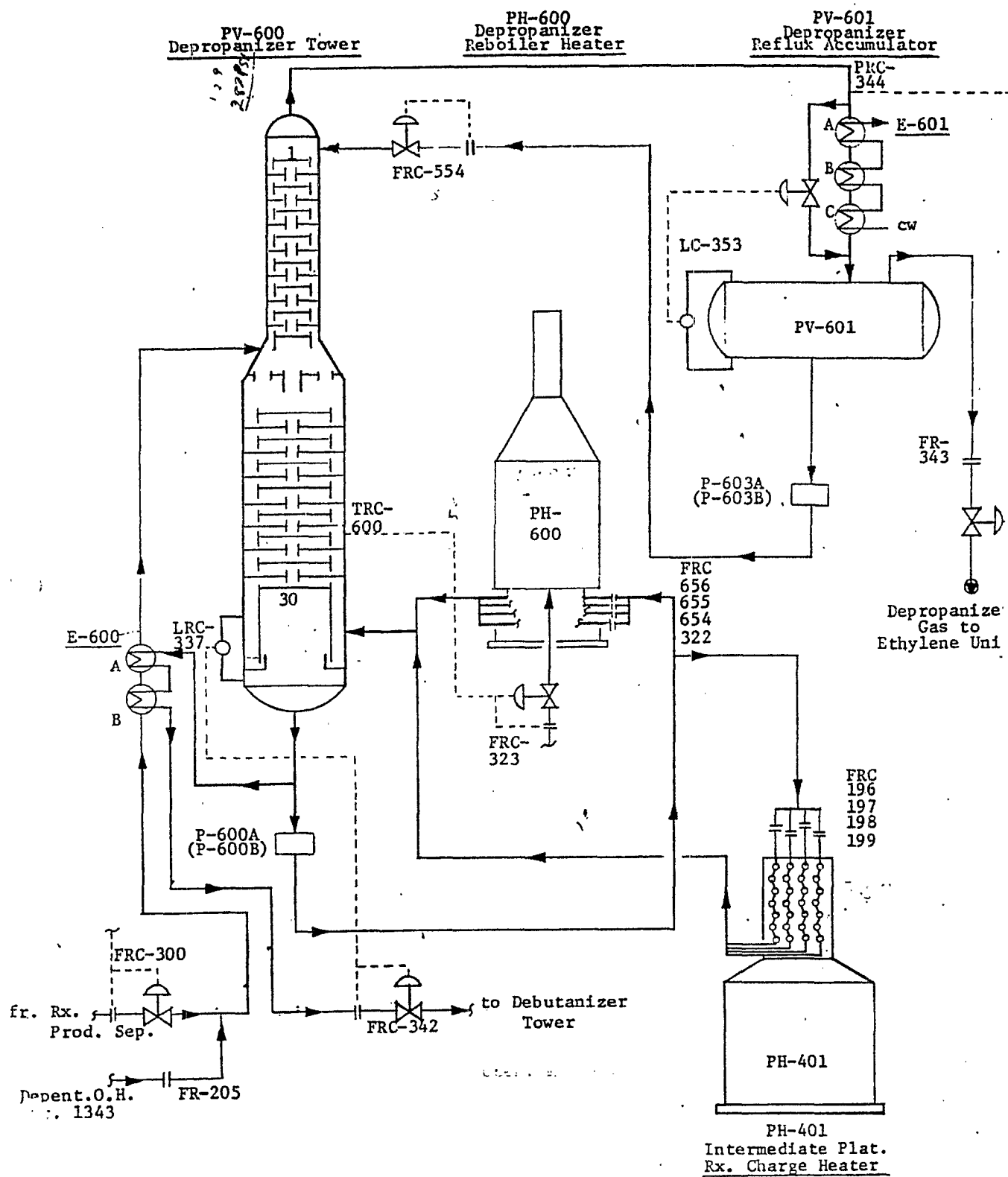
DEPROPANIZER PV-600

1. What is the purpose of the Depropanizer?
2. Which heaters supply heat to the Depropanizer?
3. Which heater is used to control the temperature of the Depropanizer?
Where is it located?
4. Where does the Depropanizer bottoms go?
5. Where does the overhead gas normally go? Where can it also go?
6. What boilaway should the propane product be?
7. How is the Depropanizer level controlled?
8. How is the Depropanizer Receiver level controlled?
9. How is the Depropanizer overhead temperature controlled?
10. How is the Depropanizer pressure controlled?
11. What is total reflux?
12. How does the hot vapor by-pass operate.

LTS:mkw:6-15-76

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FU-1342
DEPROPANIZER SYSTEM



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7
PERITANIZER

DEBUTANIZER PV-602

The purpose of the Debutanizer is to remove the butane and lighter gases from the Depropanizer bottoms charge to the tower. The Debutanizer bottoms has a high octane and is blended by Bulk Oil into motor gasoline.

The feed is introduced on tray 15 from the top. Reboiling heat is supplied by vertical tube Debutanizer Reboiler PH-601. Heater PH-601 furnishes heat for control of the 26th tray temperature. The Debutanizer bottoms are pumped through PH-601 Heater by the Debutanizer Reboiler and Bottoms pump P-601.

Vapors from the tower overhead are condensed in the E-602 condensers and accumulated in the Debutanizer Receiver PV-603. This receiver is a flooded receiver with the liquid being pumped by P-604 back to the tower as reflux or through E-603 cooler to the field as butane product. To be suitable for Alkylation Unit charge, the butane product's 5% point on the boilaway should be between 28°F and 32°F.

The Debutanizer bottoms are pumped by P-609 through Debutanizer Bottoms Cooler E-606 to the gasoline manifold. The Debutanizer bottoms to gasoline can be split into two different gasoline lines by a slipstream that takes off between the orifice plate and regulator of FRC-397. The slipstream is controlled by FRC-100.

The following is the control instrumentation used in the Debutanizer Tower:

- 1) Debutanizer Level - controlled by LRC-366 working in cascade with FRC-397 Debutanizer bottoms to gasoline. This instrument works automatically to hold a preset level. An air signal is sent from LRC-366 to FRC-397 to increase or decrease, as needed, the amount of Debutanizer bottoms to gasoline.
- 2) Debutanizer Pressure - controlled by PRC-385 working in cascade with FRC-394, butane product. The Debutanizer Receiver is a flooded receiver. To increase the pressure, the pen on PRC-385 is raised. An air signal is then sent to FRC-394, which closes off some allowing less liquid to leave the Debutanizer Receiver.
- 3) Debutanizer Overhead Temperature - controlled by TRC-580 working in cascade with FRC-376; fuel gas to PH-601. To raise the overhead temperature, the pen on TRC-580 is raised. An air signal is then sent to FRC-376 to open, allowing a greater amount of fuel gas to be burned in PH-601 heater. As the temperature in the bottom of the tower increases, hotter vapors go overhead; thus, the overhead temperature is raised.

DEBUTANIZER PV-602 - Continued

- 4) Debutanizer Reflux - controlled by FRC-358. To raise or lower the amount of reflux, the pen on FRC-358 is raised or lowered. This flow, though, usually remains constant.
- 5) Debutanizer Reboiler Flow - controlled by FRC's 377, 651, 652, & 653. To raise or lower the amount of flow through the reboilers, the pens on the FRC's are raised or lowered. This flow, though, usually remains constant.
- 6) Splitting Debutanizer Bottoms into Different Gasoline Lines - When the Debutanizer bottoms is split between the Good Gulf line and the NoNox line, FRC-100 is used to control the slipstream. To raise or lower the amount slipstream, the pen is raised or lowered.

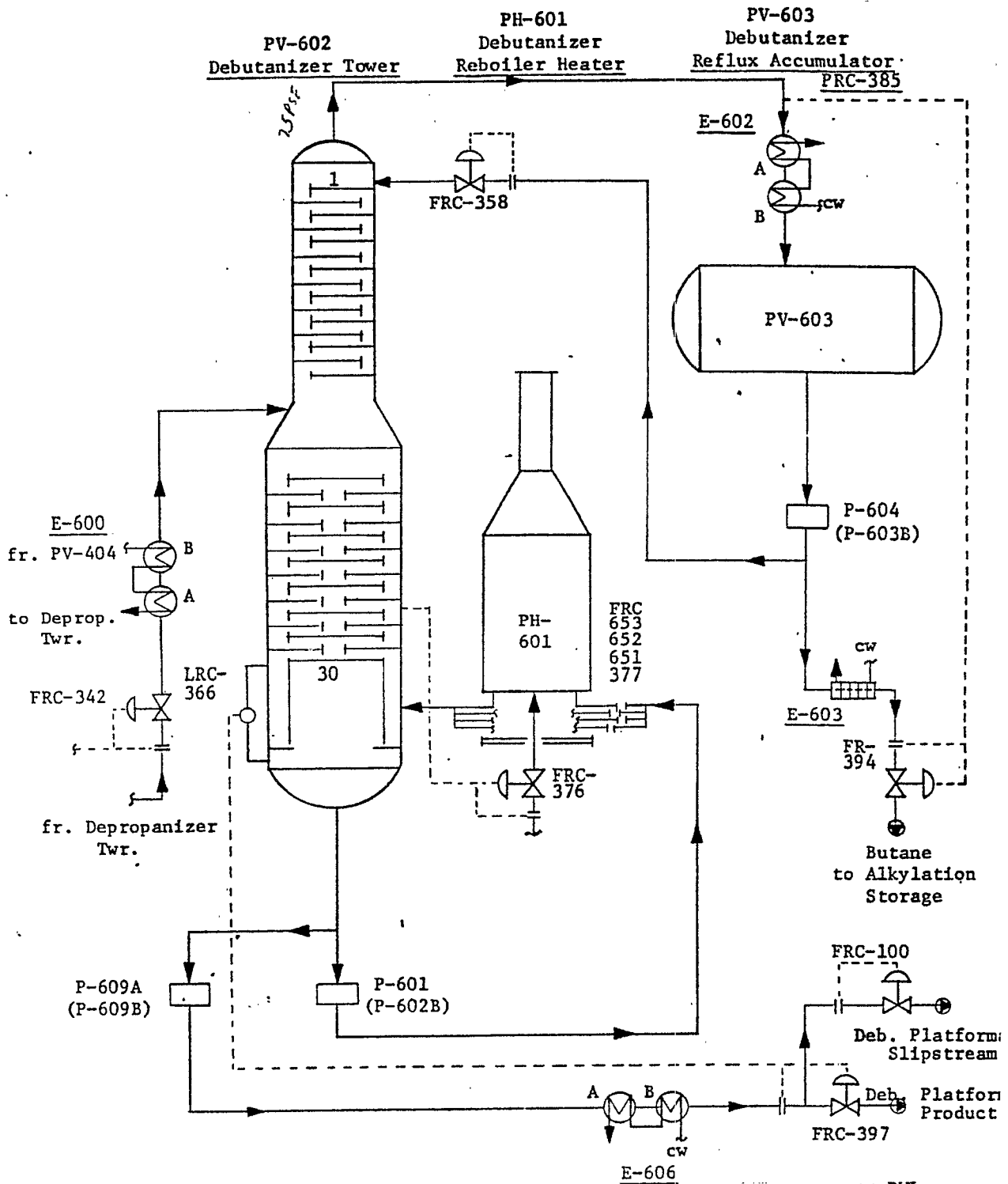
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DEBUTANIZER PV-602

1. What is the purpose of the Debutanizer?
2. Which heater supplies heat to the Debutanizer? Where is it located?
3. What is the normal distribution of Debutanizer overhead product?
4. What boilaway should the butane product be?
5. How is the Debutanizer level controlled?
6. How is the Debutanizer pressure controlled?
7. How is the Debutanizer overhead temperature controlled?
8. How is the Debutanizer bottoms split into different gasoline lines?

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PU-1342
DEBUTANIZER SYSTEM



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FUEL GAS SYSTEM

Product Gas Drum, PV-407, provides fuel gas surge and knockout of entrained liquid for refinery fuel gas. Fuel Gas Drum, PV-406, provides surge, mixing and knockout volume for a natural gas and refinery fuel gas mixture.

The Product Gas Drum floats on the refinery fuel gas system pressure; that is, refinery fuel gas can either be taken from the system or added to the system depending on the unit's needs and make. Gas streams that can be routed to the Product Gas Drum are Hydrobon Flash Drum Gas, Hydrogen from Hydrogen Filters, Propane and Hydrobon Stripper Gas. Hydrobon Flash Drum Gas can also be routed directly to the Fuel Gas Drum.

The following is the control instrumentation used on the Product Gas Drum and the Fuel Gas Drum:

- 1) Product Gas Drum Pressure--Since this vessel floats on the refinery fuel gas system, its pressure will be the same as the refinery fuel gas system.
- 2) Fuel Gas Drum Pressure--
 - a) 100% Refinery Fuel Gas--Controlled by PRC-618. To raise the pressure, the pointer on PRC-618 is raised. An air signal is then sent to the regulator to open allowing more refinery gas into the Fuel Gas Drum; thus the pressure of the Fuel Gas Drum is raised. PRC-613, natural gas to Fuel Gas Drum, should be set at a slightly lower pressure. In the event refinery fuel gas system pressure is lost, natural gas would be let into the Fuel Gas Drum automatically to hold the pressure up.
 - b) 100% Natural Gas--Controlled by PRC-613. To raise the pressure the pointer on PRC-613 is raised. An air signal is then sent to the regulator to open allowing more natural gas into the Fuel Gas Drum; thus the pressure of the Fuel Gas Drum is raised. PRC-618, refinery fuel gas to Fuel Gas Drum, should be set at a slightly lower pressure. This protects the Fuel Gas Drum from depressuring due to a loss of the Natural Gas System pressure.
 - c) Mixture of Refinery Fuel Gas and Natural Gas--Pressure controlled by PRC-613, Natural gas to Fuel Gas Drum. PRC-618 is switched to PRC-618 with the control board mounted switch. The pointer on PRC-618 is then set for the desired amount of refinery fuel gas. PRC-613 then controls the pressure.

FUEL GAS SYSTEM

1. What is the purpose of the Product Gas Drum?
2. What is the purpose of the Fuel Gas Drum?
3. What gas streams can go to the Product Gas Drum?
4. How is the pressure controlled on the Product Gas Drum?
5. How is the pressure controlled on the Fuel Gas Drum when burning 100% refinery fuel gas?
6. How is the pressure controlled on the Fuel Gas Drum when burning 100% natural gas?
7. How would you burn a 50:50 mixture of refinery fuel gas and natural gas?
How is the pressure controlled?

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HEATERS

HEATERS

The heaters consist of a steel structure with an integral self-supporting stack. The inside of the casing is lined with insulation which in turn is protected by a layer of insulating refractory brick to form the combustion chamber or firebox. Burners are located in the floor of the vertical heaters and in the floor of three of the horizontal heaters. The remaining horizontal heater has side fired burners.

The bottom section of the heater is called the radiant section. Here the surface of the tube is exposed to direct radiant heat from the burner flames. In this portion of the furnace, the major portion of heat absorbed by the tubes and, therefore, by the fluid, is transferred by means of radiation.

Above the radiant section is the convection section of the furnace. In the convection section the tubes are mechanically screened from seeing the flame burst and, therefore, depend upon convection transfer from the combustion gases sweeping over them for the major portion of their heat absorption.

Each of the horizontal heaters has a center wall or bridgewall. This wall is made of refractory material and divides the two combustion chambers. It also serves the purpose of reflecting radiant heat back to the tubes in the radiant section.

All but one of the vertical heaters have a central reradiating cone located at the upper end of the combustion chamber. This serves the dual purpose of effecting an even distribution of radiant heat and increasing the flue gas velocity at the upper section of the furnace as the temperature of the products of combustion is decreased. During normal operation the tip of the cone should be a bright cherry red in color. Under more severe firing conditions the cone will become brighter, turning a definite orange color. This condition approximates 1650°F cone metal temperature and represents the maximum continuous permissible operating load.

Draft

Natural-draft process heaters use the draft produced by the heater stack for induction of combustion air through the burners into the firebox and the transport of the combustion gases through the heater and out the stack to the atmosphere.

HEATERS-Continued

The draft produced by the stack depends on the height of the stack and the temperature of the combustion gases going up the stack. The column of hot combustion gases in the stack weighs less than column of air of equal height at ambient temperature.

The draft is measured in inches and fractions of an inch of water. Draft is a slightly lower pressure than atmospheric pressure and is therefore a negative gauge pressure.

Excess Oxygen

The single most important controllable variable affecting heater efficiency is excess oxygen content in the flue gas. There are other variables influencing process heater fuel consumption such as stack temperature, charge stock inlet temperature and charge stock composition. But none of these are directly controllable by the operator. Only excess oxygen is subject to his direct and continuous control by the adjustment of burner air registers.

A deficiency of oxygen will result in incomplete combustion of the fuel gas. Instead of being burnt in the furnace, the unburnt combustibles will go through the stack to the atmosphere, thus, the heater efficiency is reduced.

Too much oxygen will also result in a decrease of heater efficiency. When too much air is present, a portion of the heat of combustion is used to heat up the extra oxygen instead of heating up the firebox.

It is therefore very important that the excess oxygen content in the flue gas be held between two and four percent. The oxygen content of the flue gas should be monitored periodically with a portable oxygen analyzer, and the primary and secondary air adjusted as needed to hold the target oxygen content.

The primary air mixes with the fuel gas before the burner tip. It should be adjusted so the flame burns immediately above the burner tip. The secondary air mixes with the fuel gas at the burner tip. It is used to control the amount of excess oxygen in the heater. See Exhibit 5.

Flame Impingement

Flame impingement on tube surfaces will greatly decrease tube life and may result in a serious tube failure. The furnace should be checked for

HEATERS-Continued

any signs of flame impingement at regular intervals and particularly after any change in load. Mis-alignment of the burners, insufficient combustion air, or enlargement and corrosion of the burner ports are frequently the cause of incorrect flame pattern.

LTS:mkw:11-26-75

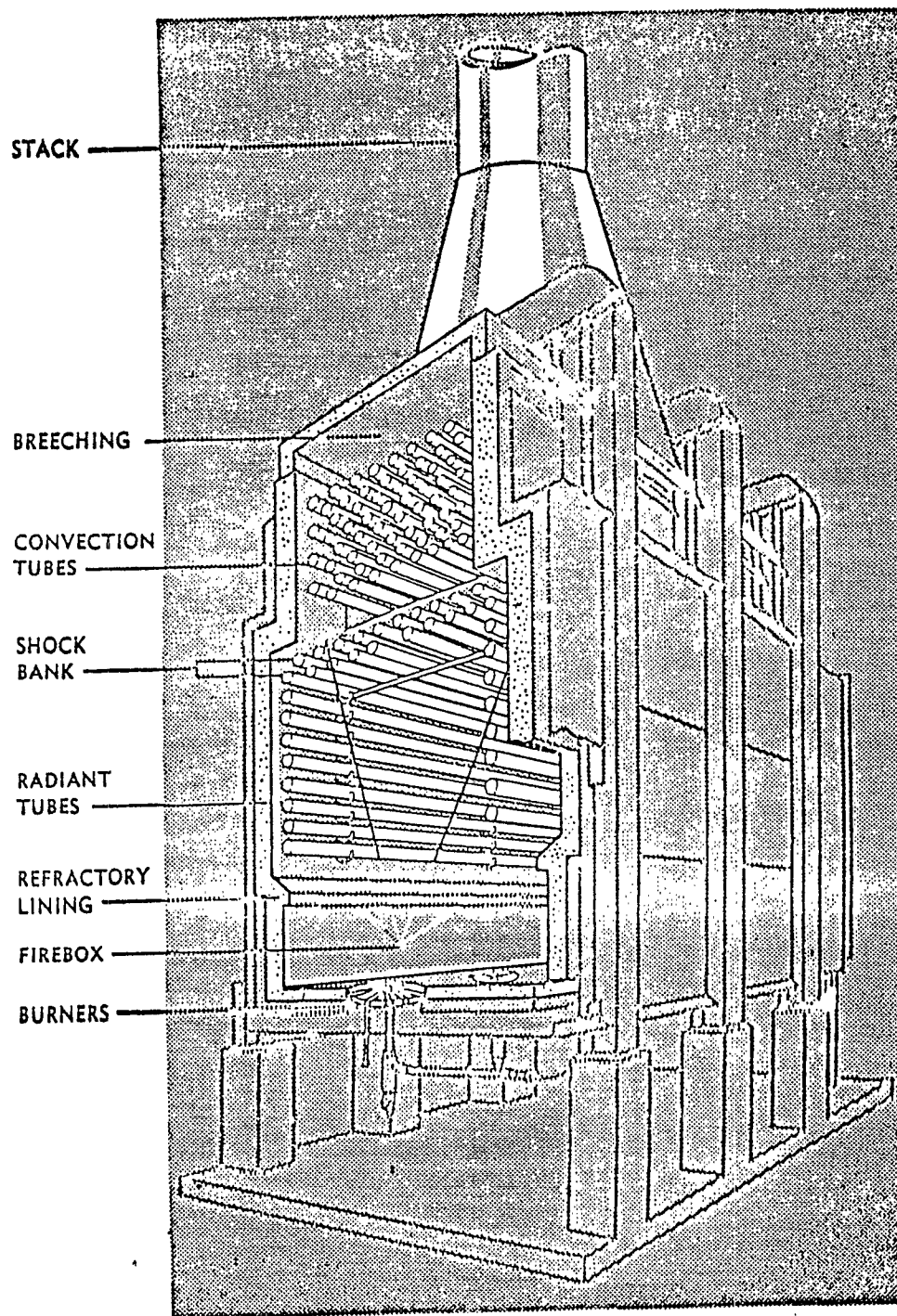


EXHIBIT 1
HORIZONTAL HEATER

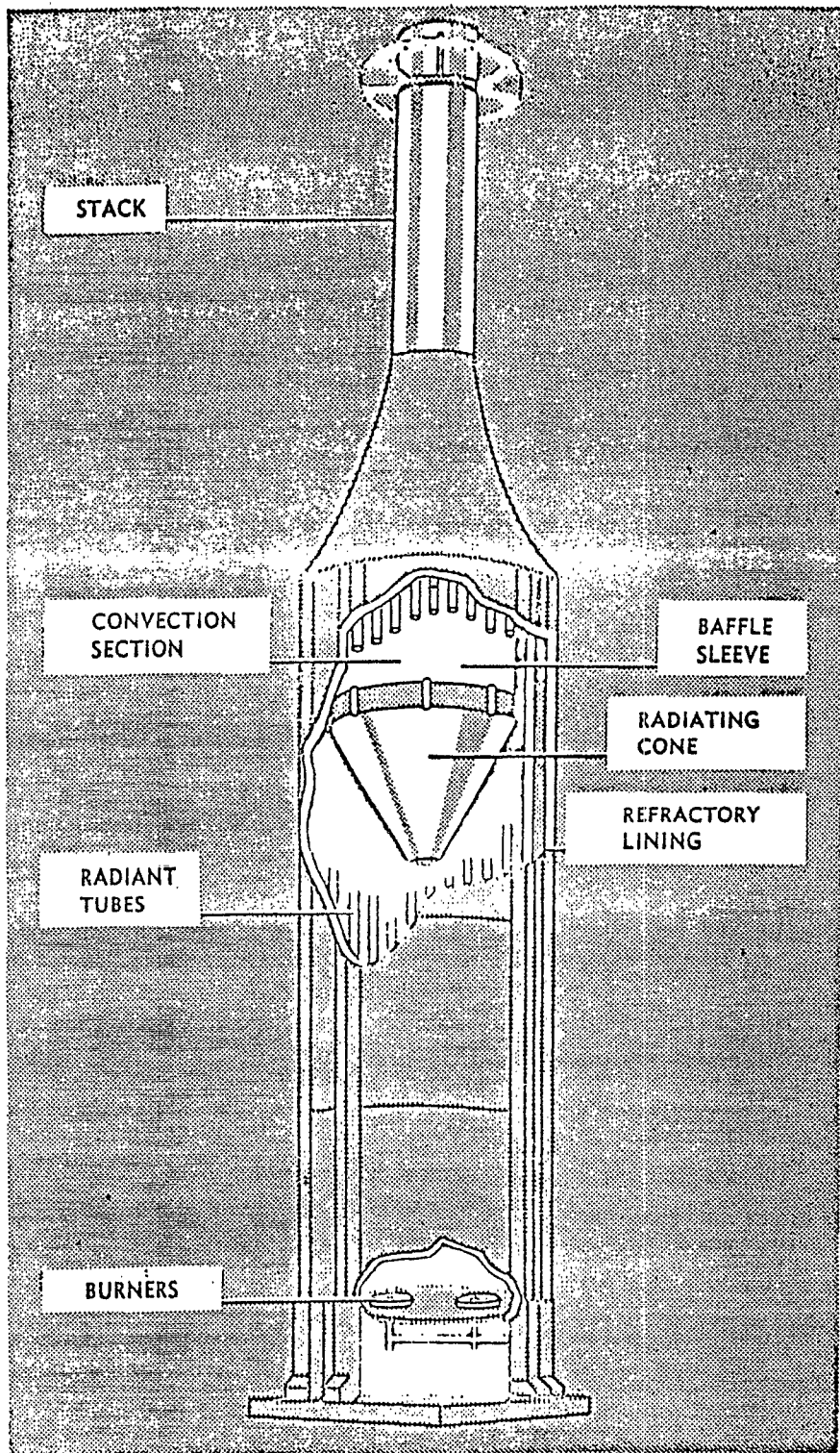


EXHIBIT 2
VERTICAL HEATER

CHEV B8 6539

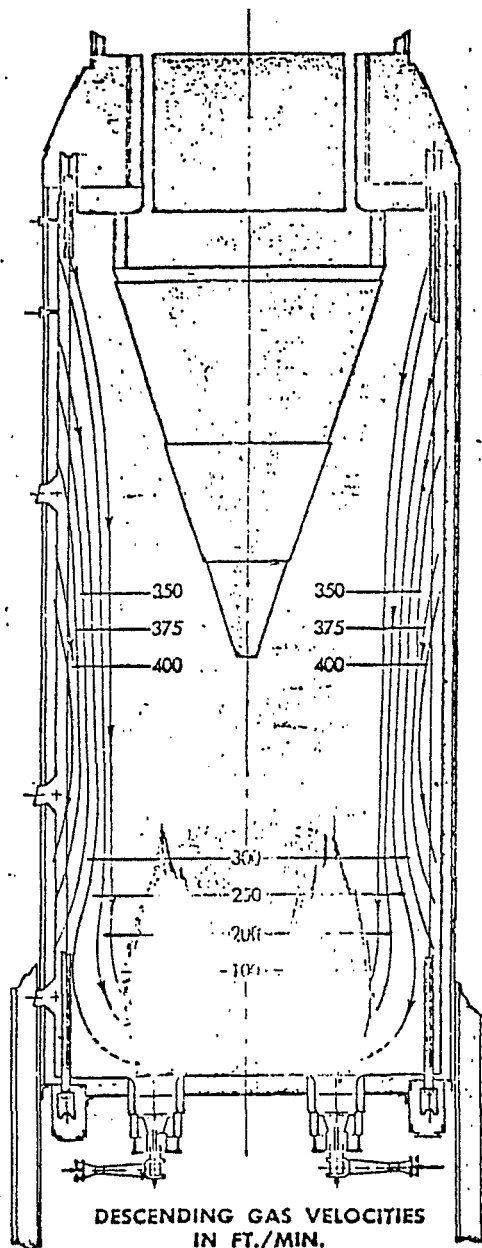


Exhibit 3

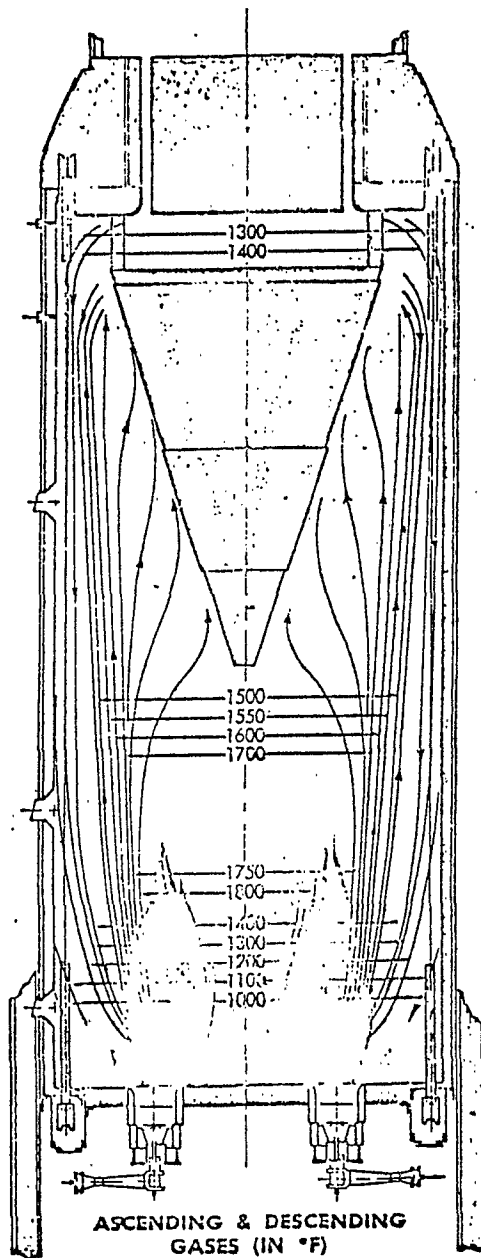
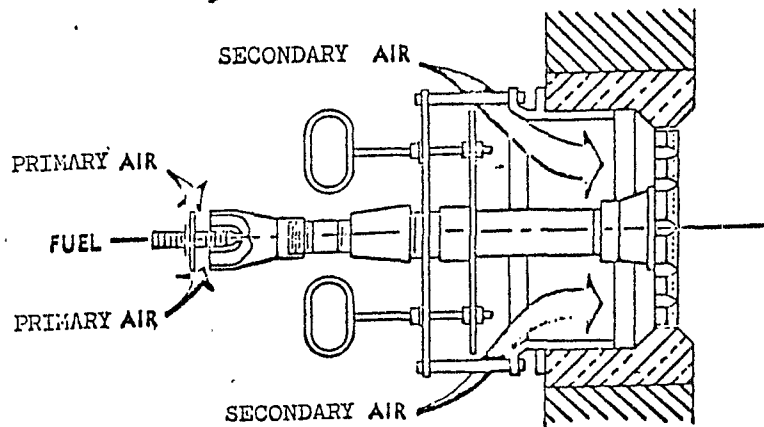


Exhibit 4



BURNER
Exhibit 5

Heater Start-Up Procedure

1. Start flow through the heater. Flow distribution between the passes should be adjusted as closely as possible.
2. Steam firebox for 30 minutes.
3. Roll in gas spool(s).
4. Check to be sure fuel gas valves to individual burners are blocked.
5. After heater has steamed for 30 minutes, light the required number of burners to dry out firebox (3 burners per side horizontal heaters and 1 or 2 burners per vertical heater). The by-pass valve around the fuel gas regulator should be used to light the burners and then adjusted to hold 3-5 psig fuel gas header pressure.
6. After fires are lit, check outlet temperatures of each pass. The outlet temperatures of each pass should be approximately equal. If there is a large discrepancy, adjust flow through passes. The outlet temperatures should be closely monitored until the heater reaches normal operating conditions.
7. Dry firebox for 30 minutes before lighting additional burners.
8. Light additional burners as needed to begin raising the heater outlet temperatures.
9. DO NOT RAISE OUTLET TEMPERATURES FASTER THAN 150°F PER HOUR.
10. If additional burners will supply too much heat to the firebox, increase the fuel gas header pressure slightly using the by-pass valve.
11. Set by-pass valve at 3-5 psig after lighting all burners.
12. After setting by-pass for 3-5 psig burner pressure with all burners lit, put firing gas regulator in service.
13. Continue bringing up outlet temperature to normal operating conditions using automatic fireman.

LTS:cjm:12-2-75

COMPRESSORS/

5. General Notes on the subject of the document is as follows :

1.

2.

3.

COMPRESSORS

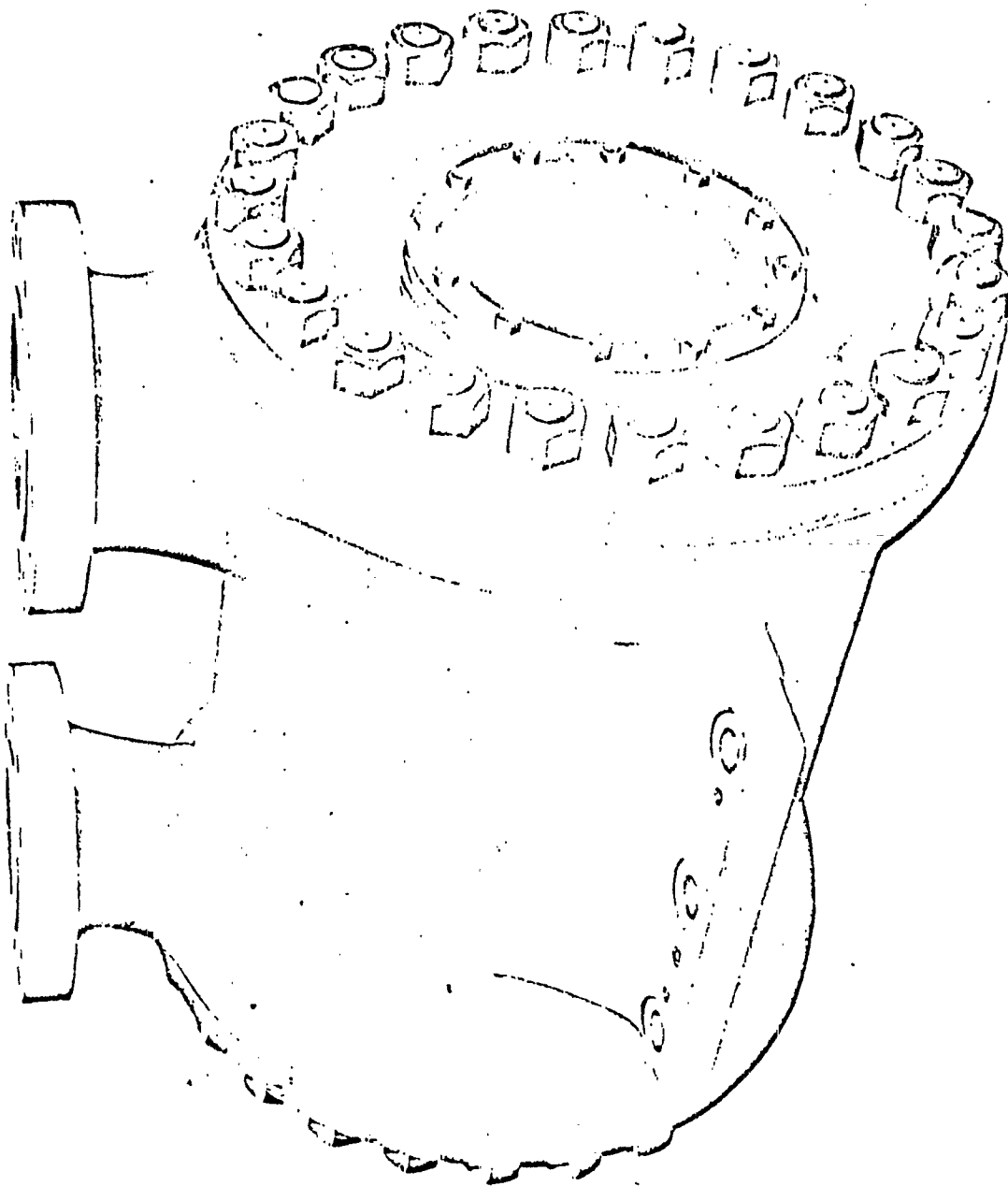
The Barrel Type Compressor is essentially a high speed, high pressure machine consisting of two or more radial flow type impellers mounted on a shaft, rotating within a specially designed casing. Compression of the gas is accomplished by drawing the gas into the compressor through the inlet connection and directed into the inlet, or eye, of the first impeller through a set of inlet guide vanes. The guide vanes serve to direct the gas in the proper direction.

The impeller, or wheel, rotates at high speeds. This high rotative speed causes the gas to be thrown outward by centrifugal force and with high velocity. Centrifugal force creates a lower pressure at the impeller inlet so that more gas is forced in by the external pressure in the suction pipe.

The velocity is decreased and converted into pressure in the diffuser channel following the impeller. The gas then crosses over and returns to the next impeller through a set of return channels, including guide vanes to direct the gas into the next impeller properly. As the gas goes through each stage its pressure is increased. After the gas leaves the last stage impeller, it is collected in the volute from which it passes into the discharge pipe.

The shaft of a compressor has a tendency to vibrate at its own natural frequency depending on the length and stiffness of the shaft. The faster the shaft rotates, the faster the vibrations will occur. On a high speed multi-stage machine, there is a speed range below the normal operating speed in which there is an excessive amount of vibration. This is known as the critical speed. If allowed to operate in the critical speed range, the excessive vibration can cause damage to the bearings, seals, or rotor. It is very important to pass through the critical speed of the machine as quickly as possible with the least amount of vibration.

LTS:mlw:12-2-75:



CLARK VERTICAL SPLIT CASE, MULTI - STAGE, CENTRIFUGAL COMPRESSOR



CHEV B8 6547

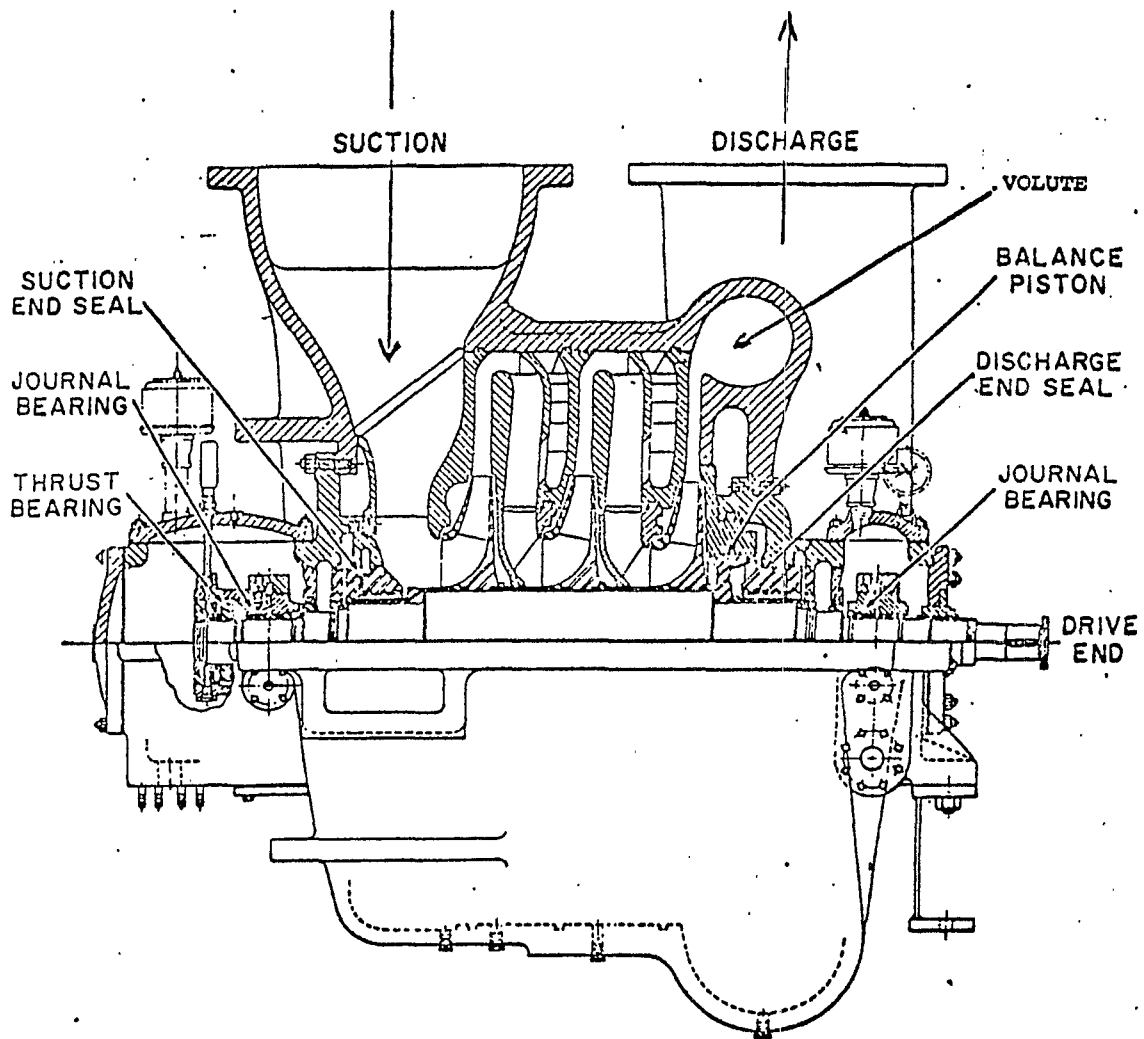
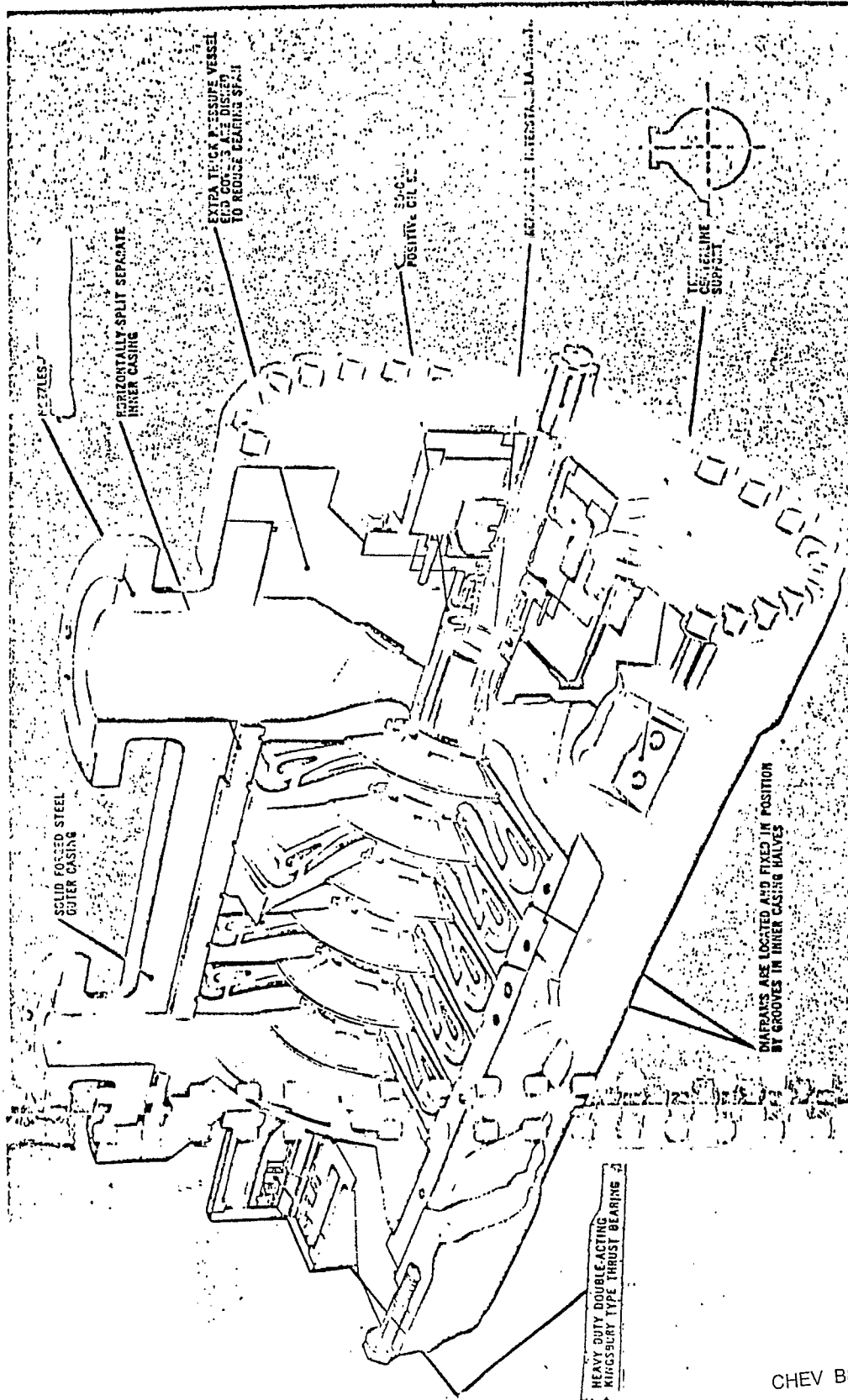
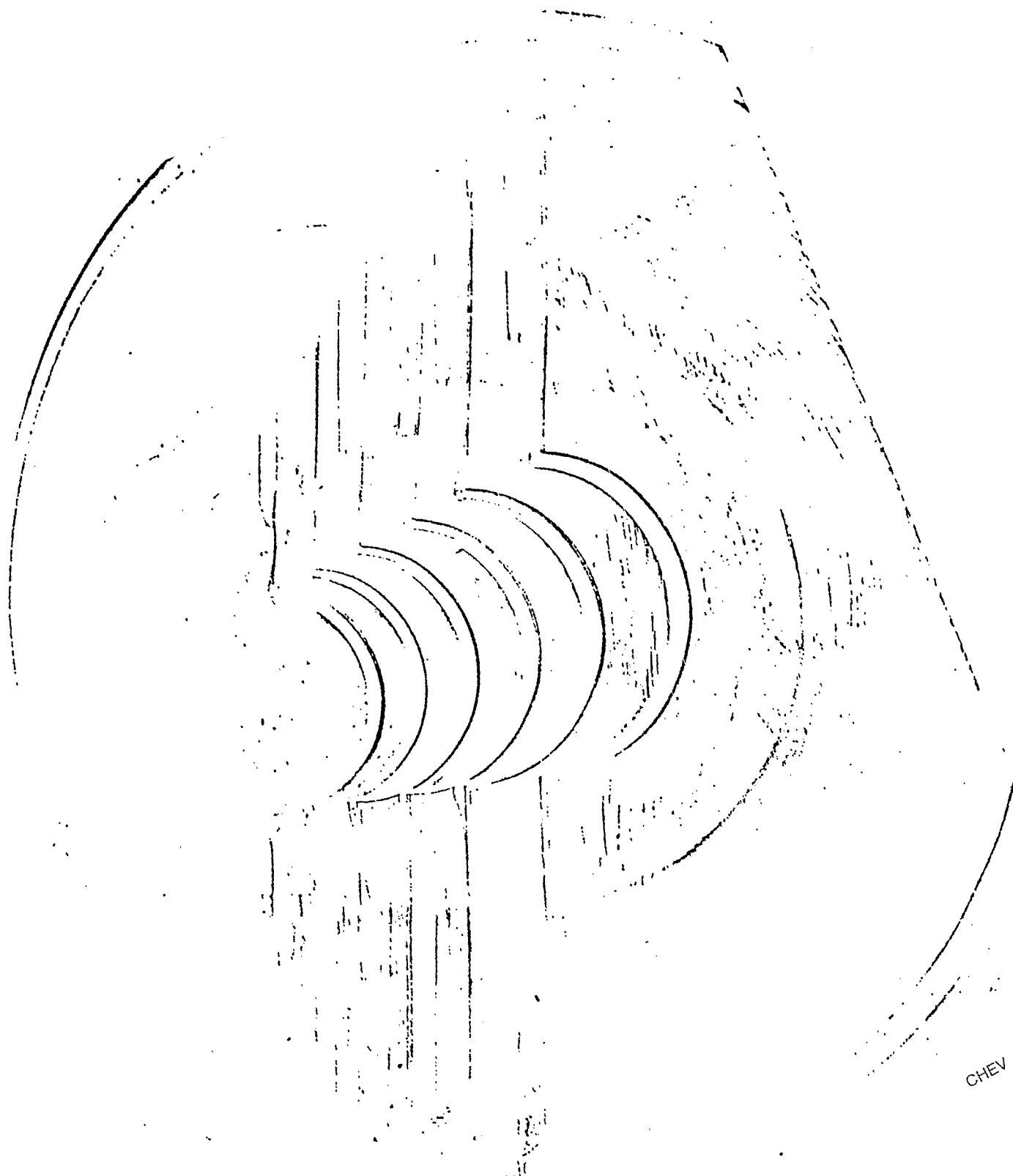


FIGURE 1
TYPICAL COMPRESSOR WITH
THRUST BEARING ON SUCTION END

SIX STAGE HIGH PRESSURE

VERTICALLY-SPLIT COMPRESSORS





CHEV B8 6550

NOMENCLATURE

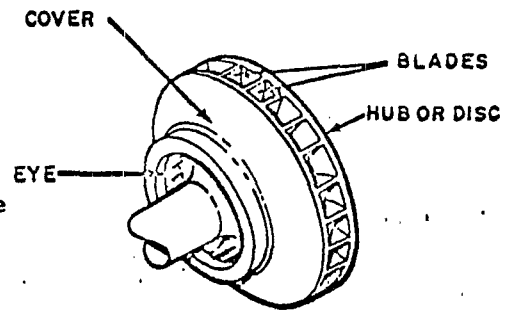
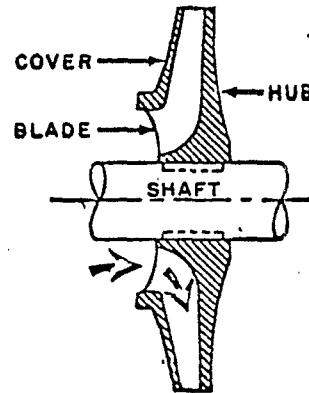
The purpose of this section is to familiarize the reader with the names and functions of various parts of a centrifugal compressor.

IMPELLER OR WHEEL

The "BLADE" increases the velocity of a gas by rotating about the center line and causing the gas to move from the inlet of the blade (or wheel) to the tip or discharge. The difference in the distance from the axis of rotation of the blade inlet and the blade discharge causes an increase in velocity which results in an increase in kinetic energy.

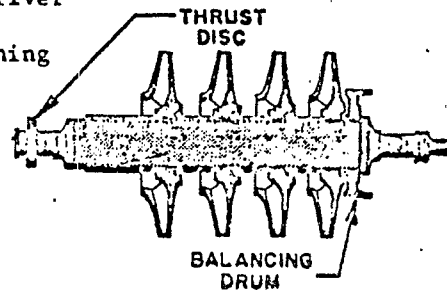
The DISC or HUB for either a closed or a semi-open wheel serves two functions ...to drive the blade and to confine the gas to the blade area.

Three parts - BLADE, COVER and DISC - constitute the IMPELLER, also known as the wheel. The wheel illustrated is a closed wheel, so-called as the gas is confined on both sides of the blade.



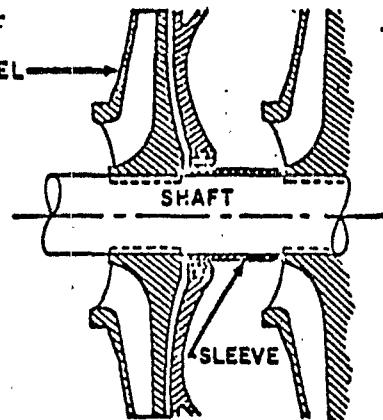
SHAFT

The SHAFT is used to support the wheels and to deliver the driving power to the discs. Methods of fastening the wheels to the shaft are many and varied. The most common method is the combining of shrink fit with keys



SHAFT SLEEVES are used between wheels on the shaft for

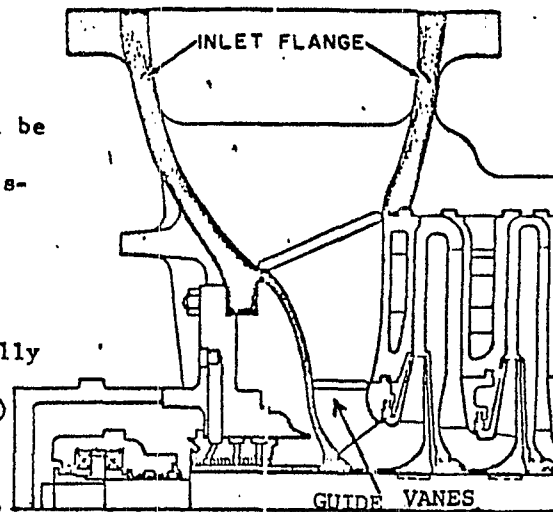
axial location of the wheels, and to afford wear- ing surfaces for interstage seals. In certain instances shaft sleeves protect the shaft from corrosive elements in the gas. Sleeves are also used in conjunction with shaft seals and occasionally for bearing surfaces.



ROTOR

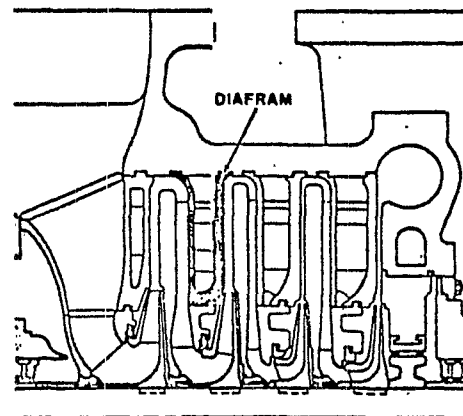
All of the parts mounted on the shaft, together with the shaft, are known as the ROTOR. The rotor is one of the two major elements and shall be considered by its parts from the inlet to the discharge.

The inlet flange connects the inlet nozzle to the piping system. The inlet nozzle systematically increased the velocity (by reducing the pressure) of the gas, guides it to the eye of the first impeller, and distributes the gas around the 360° of the impeller eye.



DIAPHRAGM

A full diaphragm is a stationary element between two stages which forms half of the diffuser channel of the earlier stage, part or all of the return bend, all of the return channel and half of the diffuser of the later stage. The diaphragm also supports the shaft seal following the earlier stage and the eye seal of the later stage.

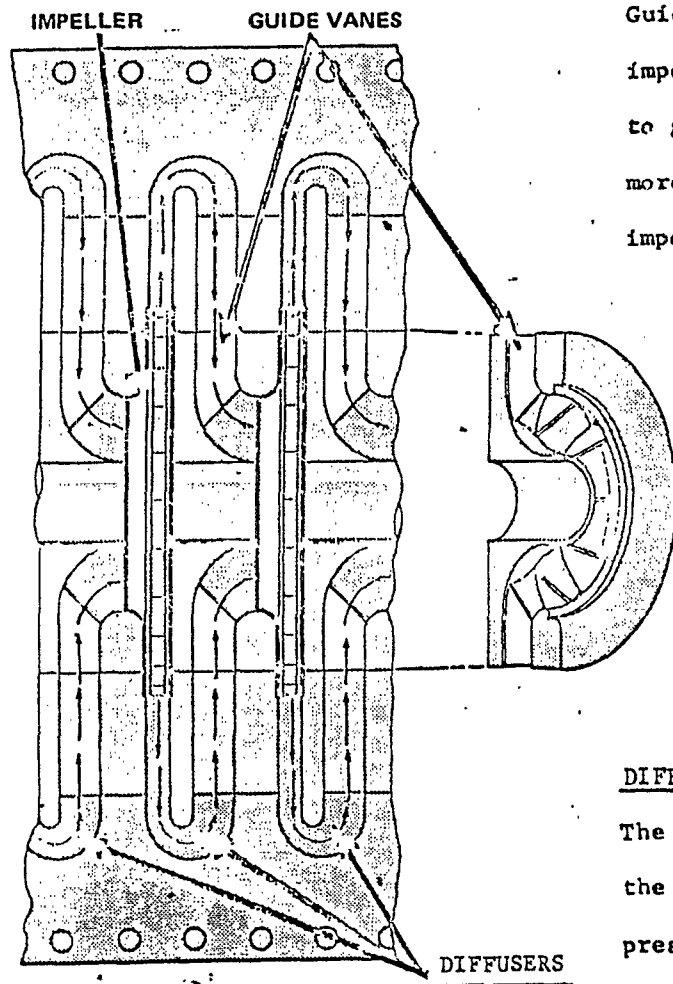


DISCHARGE VOLUTE

Volute collects the gas from last stage diffuser and delivers the gas to the discharge nozzle

GUIDE VANES

Guide Vanes are just ahead of each impeller inlet or eye and are designed to guide the flow of gas more evenly and more efficiently into the eye of each impeller.



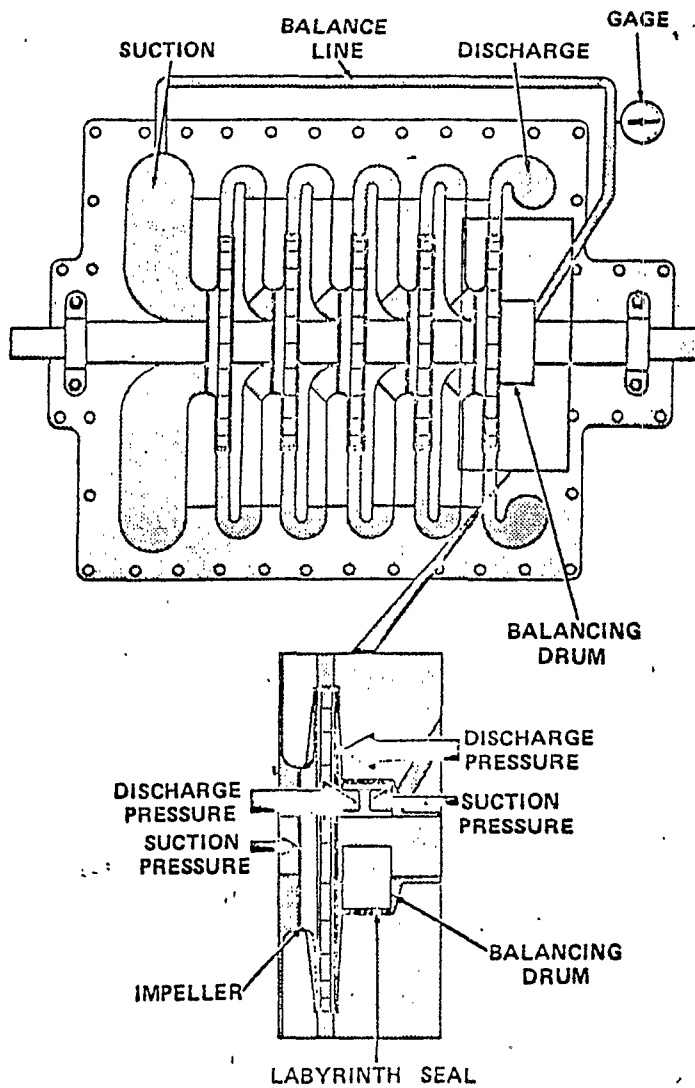
DIFFUSER JOB

The diffuser converts the velocity of the gas into pressure inside the compressor.

BALANCING DRUM

Balancing Drum is used to equalize thrust when the axial thrust is too great for the thrust bearing. This is accomplished by two forces balancing each other out because they are exerted in opposite directions.

Compare these forces.



BEARINGS

The rotor is supported by two precision journal bearings having babbitt faced liners. Pressurized oil for lubrication and cooling is furnished by the oil supply system.

The balancing drum, located on the discharge end of the rotor, is sized to direct the thrust toward the suction end of the rotor. This thrust is absorbed by a Michell, (Kingsbury Type), thrust bearing. The thrust bearing is designed to take axial thrust from either direction. This is accomplished by locating thrust shoes on either side of the thrust disc. A spacer is used in assembling the thrust disc to the shaft to center the impellers in their correct axial location.



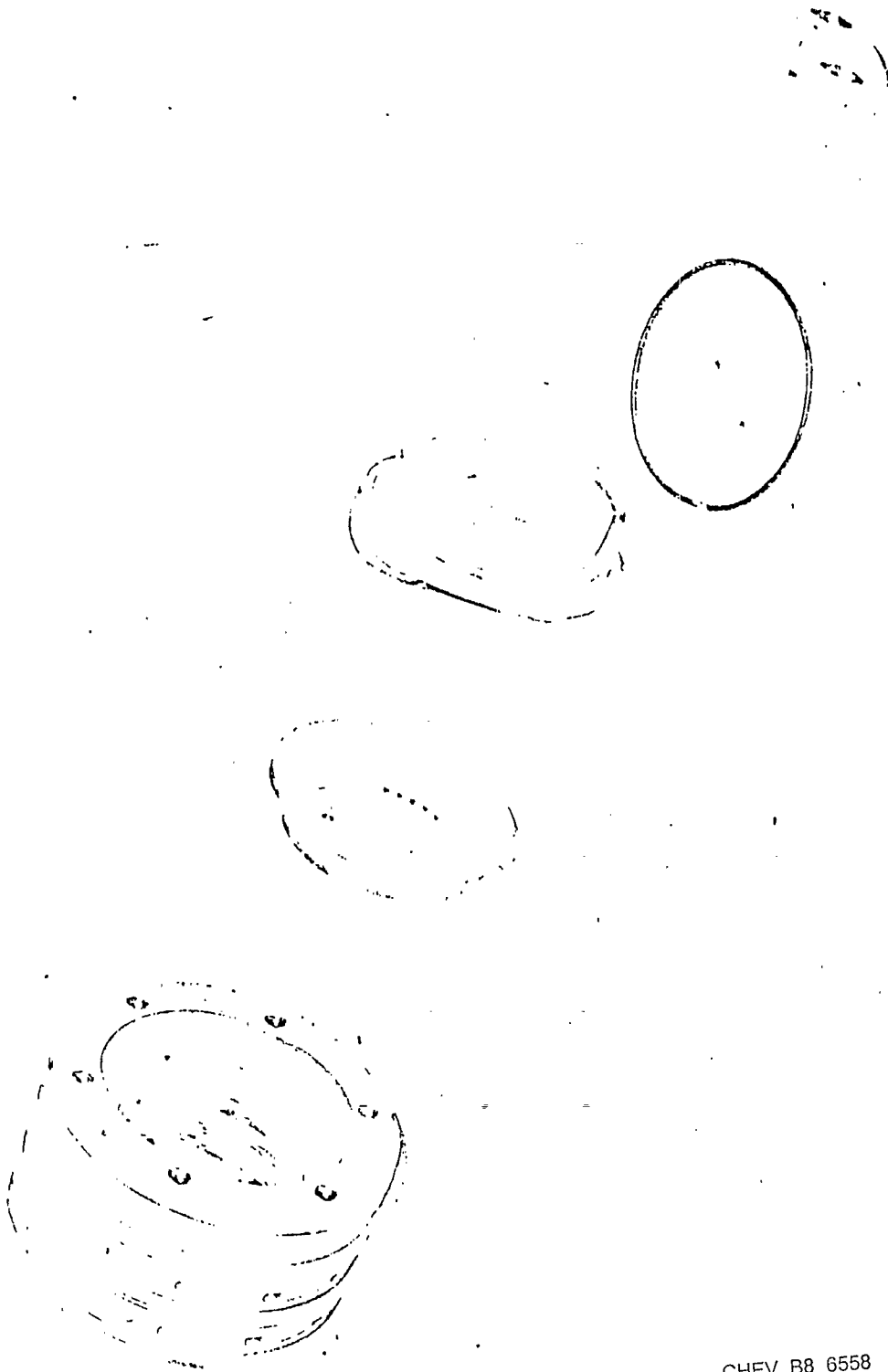
CHEV B8 6556

SHAFT SEALS

The seal in use on the barrel type Clark Centrifugal Compressor is a high pressure internal floating ring type oil seal. The floating ring type seal was developed to isolate the gas stream from the lube oil and bearing chambers or to seal the shaft opening into the compressor in certain other high pressure applications.

The floating ring seal maintains a pressure tight barrier along a rotating shaft by use of two floating sleeves, concentric and with accurate radial clearances with relation to the shaft. These rings are able to move radially, following any minute radial action which the shaft may be permitted by bearing clearances. Seal oil is fed between the two rings at a pressure approximately 5 psi greater than the gas pressure being sealed. against.

Under these conditions there is always a small flow of seal oil inward to the area of high pressure gas. It is collected in the high pressure chamber and disposed of thru a suitable trap. If the high pressure gas is harmful to the oil through contamination, the small inward flow may be discarded as it emerges from the trap. The application of this type of seal results in no gas leakage externally from the compressor.



CHEV B8 6558

H. SHAFT SEALS

Shaft seals, located at each end of the compressor shaft are used to separate the gas stream from the bearing chamber.

(1) Labyrinth Seals

The simplest, most rugged, and most economical of all shaft seals is the straight labyrinth seal (Figure #3). This seal consists of a series of thin strips or fins which are normally mounted in a stationary ring which maintains a close clearance between the shaft and the tip of the fins. The seals are usually made of soft metal, such as brass or aluminum. So that if it rubs on the shaft it will not cause any extensive damage.

(a) Basic Principles of a Labyrinth Seal Operation

As gas enters the seal from the gas side of the compressor, it forms "eddies" or whirlpools in each "V" groove and fin compartment.

As gas leaks pass from one "V" groove to the next, there is a decrease in pressure. "Eddies" forming in each "V" groove makes it harder for the gas to leak through. As it loses its pressure it will cancel out its ability to flow past the labyrinth seal into the atmosphere.

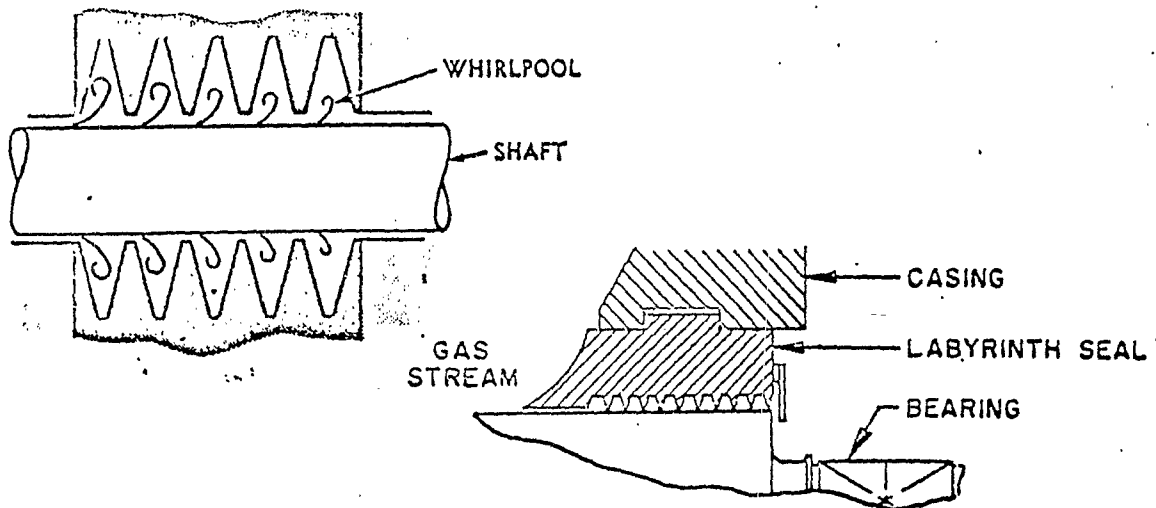


FIG. 3

FIGURE
STRAIGHT LABYRINTH SEAL

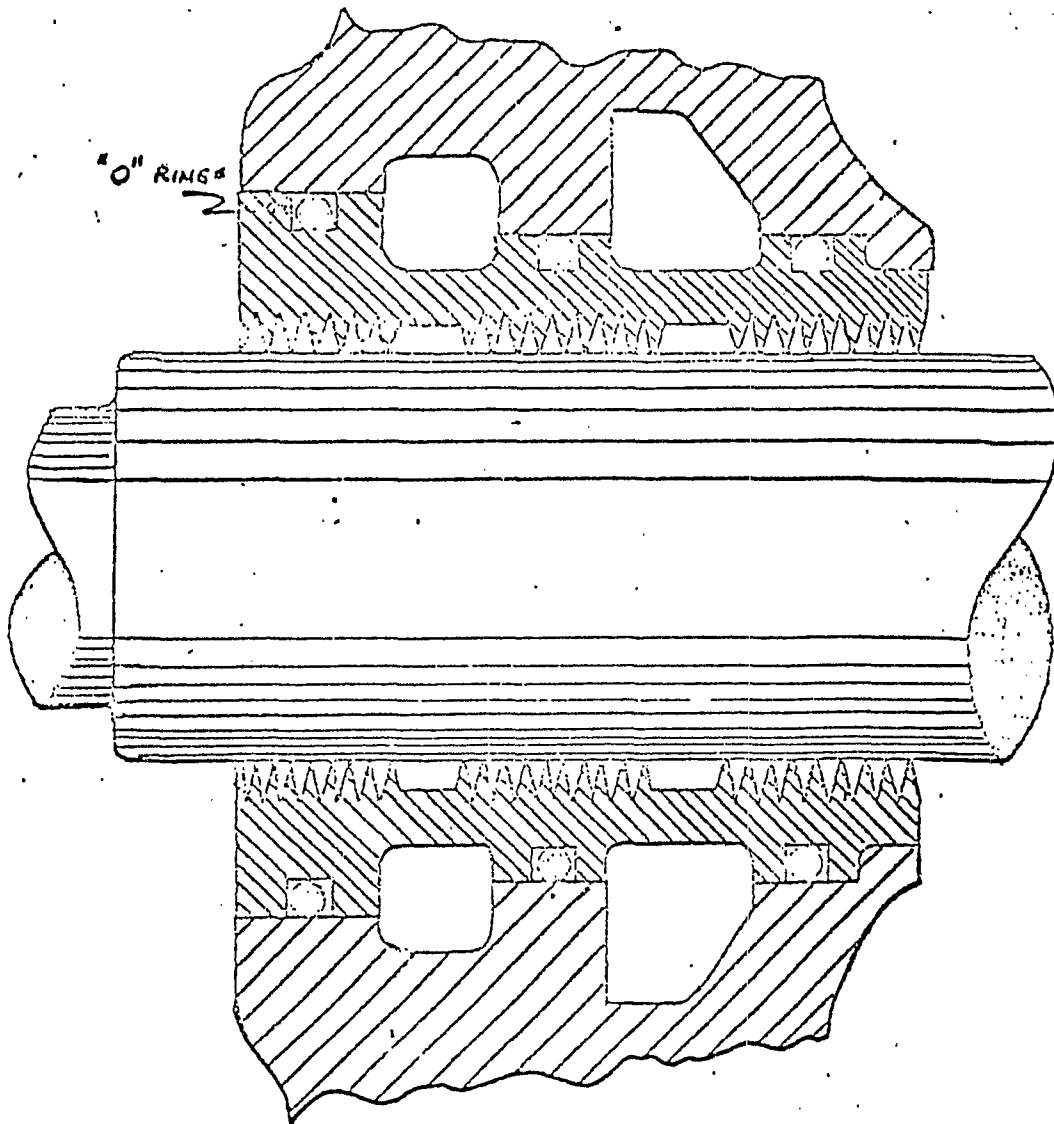
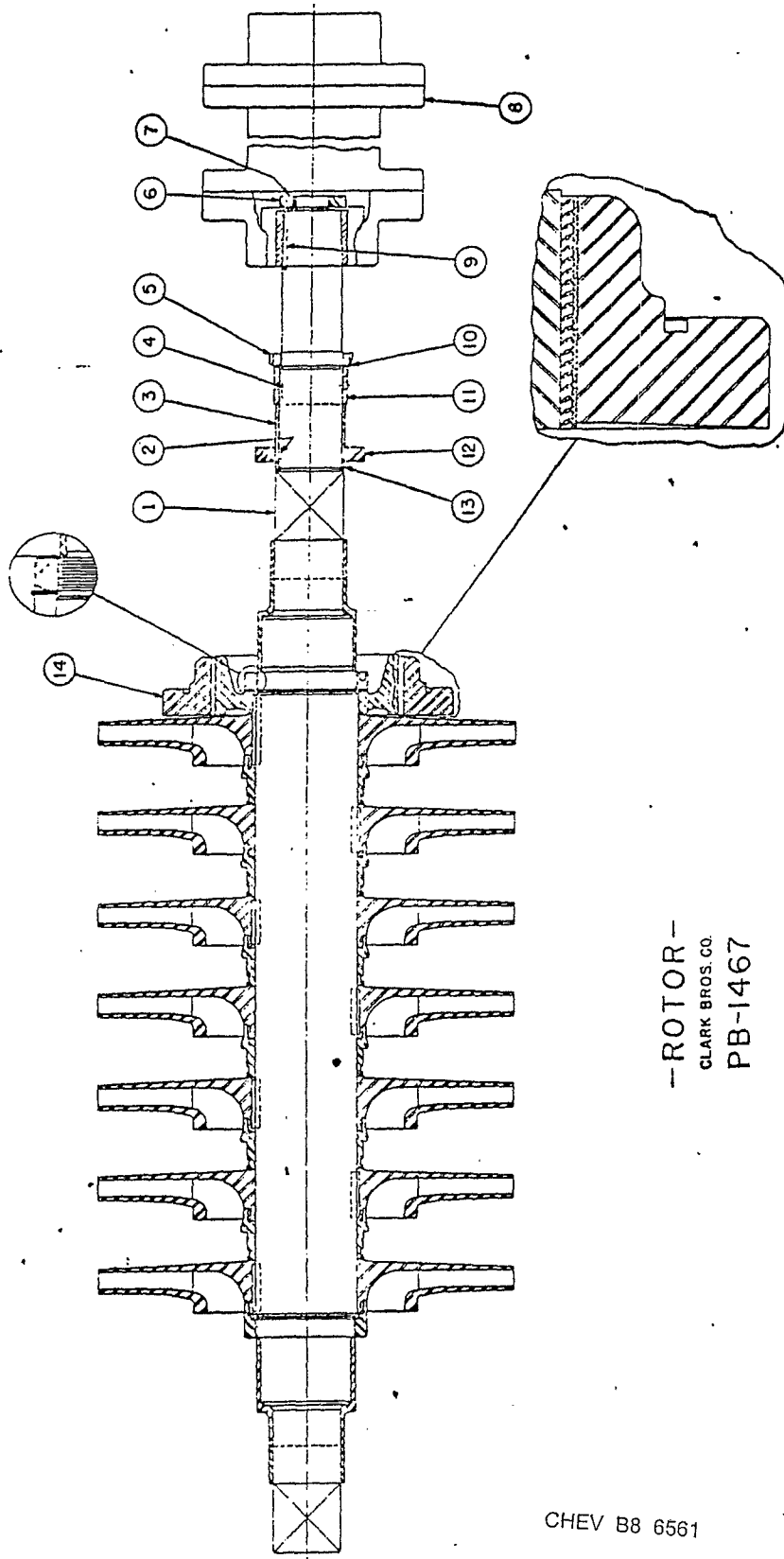


FIGURE 3 Labyrinth Seal



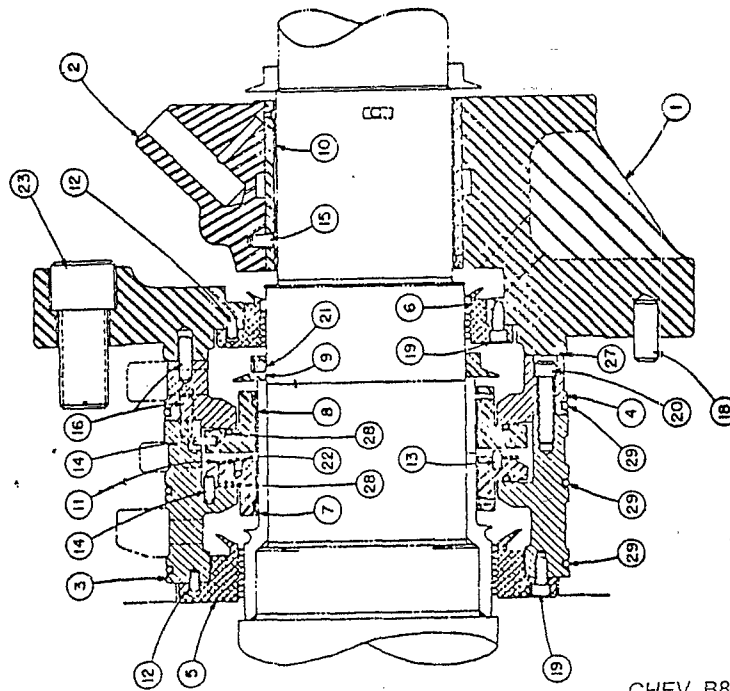
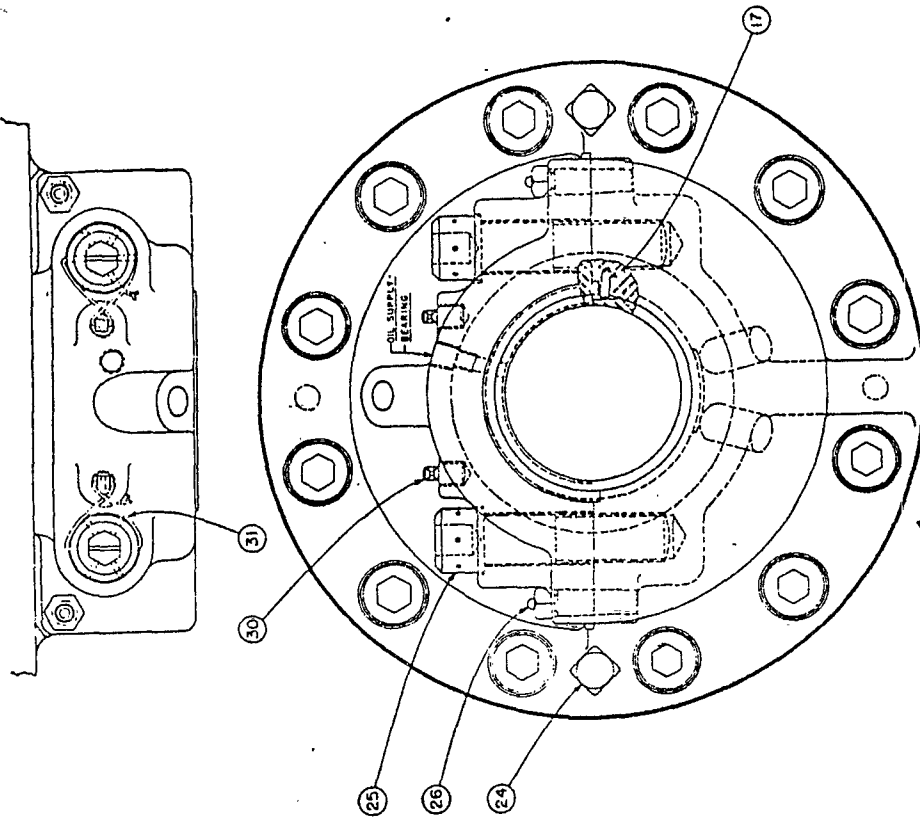
-ROTOR-
 CLARK BROS. CO.
 PB-1467

CHEV B8 6561

ROTOR

Assembly PB-1467

<u>Item No.</u>	<u>Part</u>
1	Impeller Shaft
2	Thrust Disc Key
3	Worm Spacer
4	Not Used
5	Locknut - L.H.
6	Coupling Locknut
7	Setscrew
8	Fasts Coupling
9	Coupling Key
10	Lockwasher Ball Brg.
11	Not Used
12	Thrust Disc
13	Thrust Disc Spacer
14	Balance Piston Labyrinth



- SHAFT BEARING & OIL SEAL

— CLARK BROS. CO. —

PB-1627

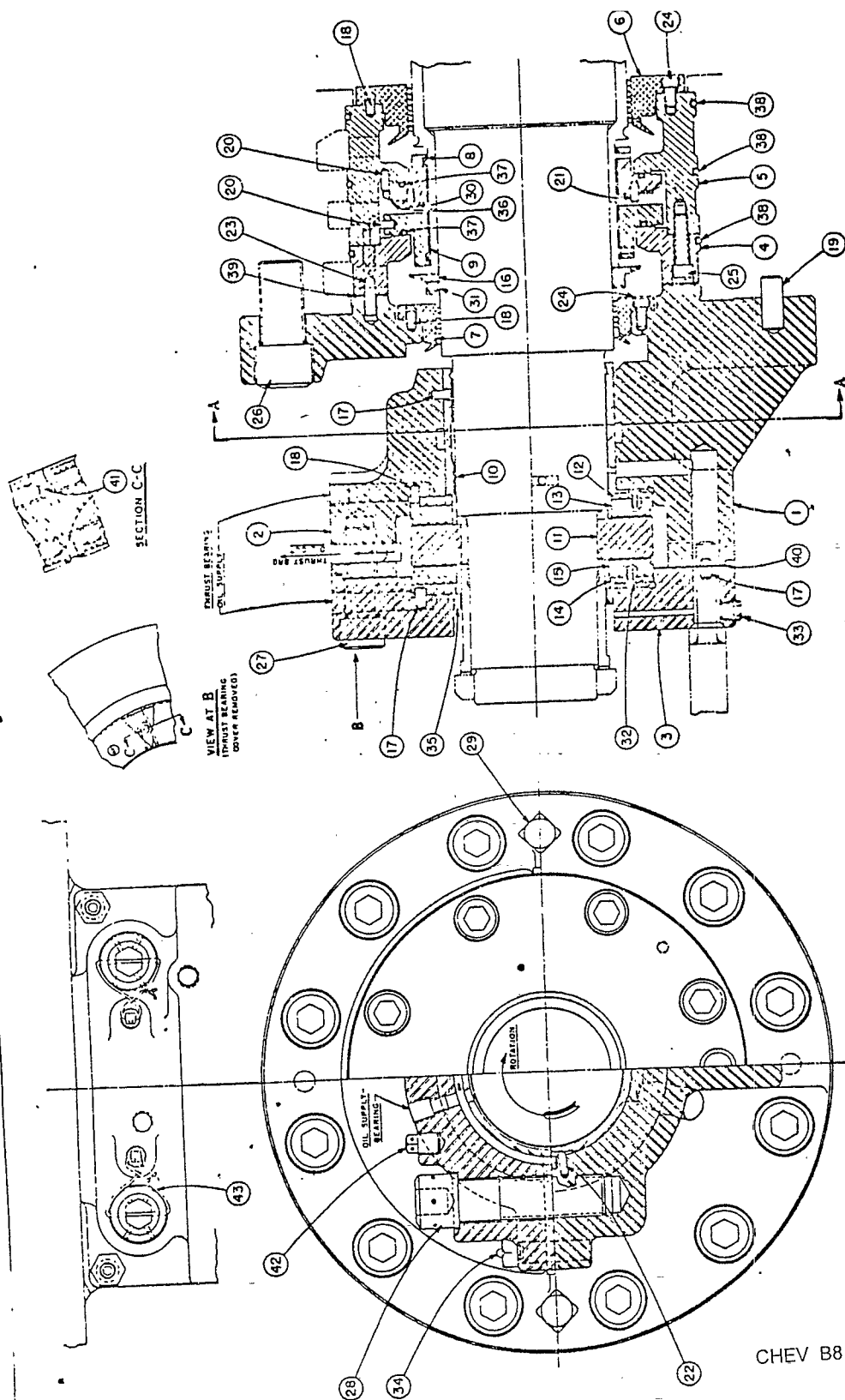
CHEV B8 6563

SHAFT BEARING & OIL SEAL - DISCHARGE END

PB-1627

<u>Item No.</u>	<u>Part</u>
1	Bearing Housing
2	Bearing Cap
3	Seal Housing - Inner Oil Seal
4	Seal Housing - Inner Oil Seal
5	Inner Seal Labyrinth
6	Outer Seal Labyrinth
7	Inner Floating Ring
8	Outer Floating Ring
9	Oil Slinger
10	Bearing Liner
11	Seal Ring Spring
12	Dowel Pin
13	Dowel Pin
14	Dowel Pin
15	Dowel Pin
16	Dowel Pin
17	Dowel Pin
18	Dowel Pin
19	Capscrew
20	Capscrew
21	Setscrew
22	Machine Screw
23	Capscrew
24	Setscrew
25	Capscrew
26	Pull Dowel & Nut
27	Gasket - Inner Seal
28	"O" Ring
29	"O" Ring
30	Screw- Wire Locking
31	Locking Wire

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SHAFT BRG., THRUST BRG. & OIL SEAL

CLARK BROS. CO

PB-1628

PARTIAL SECTION A-A

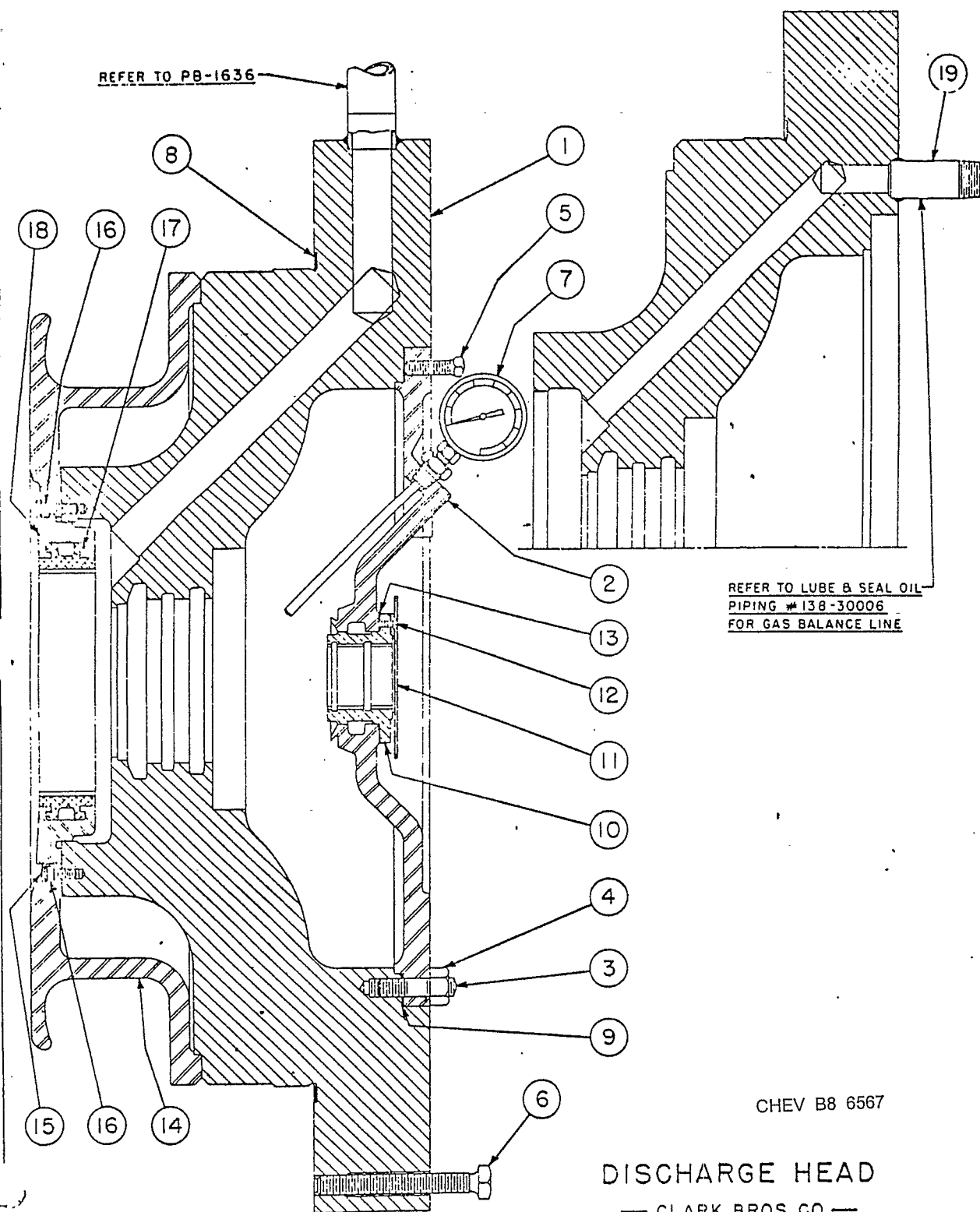
CHEV B8 6565

SHAFT BEARING, THRUST BEARING & OIL SEAL INTAKE END

PB-1628

Item No.	Part
1	Bearing Housing - Intake End
2	Bearing Cap - Intake End
3	Thrust Bearing Cover
4	Seal Housing - Inner Oil Seal
5	Seal Housing - Inner Oil Seal
6	Seal Labyrinth - Inner
7	Seal Labyrinth - Outer
8	Floating Ring - Inner
9	Floating Ring - Outer
10	Bearing Liner
11	Thrust Disc
12	Base Ring -L.H.
13	Thrust Bearing Shoes - L.H.
14	Base Ring - R.H.
15	Thrust Bearing Shoes - R.H.
16	Oil Slinger
17	Dowel Pin
18	Dowel Pin
19	Dowel Pin
20	Dowel Pin
21	Dowel Pin
22	Dowel Pin
23	Dowel Pin
24	Capscrew
25	Capscrew
26	Capscrew
27	Capscrew
28	Capscrew
29	Setscrew
30	Machine Screw
31	Setscrew
32	Machine Screw
33	Pipe Plug
34	Pull Dowel & Nut
35	Thrust Bearing Seal Ring
36	Seal Ring Spring
37	"O" Ring Silicone
38	"O" Ring Silicone
39	Gasket Inner Seal
40	Thrust Bearing Housing Gasket
41	Retaining Pin
42	Screw - Wire Locking
43	Locking Wire

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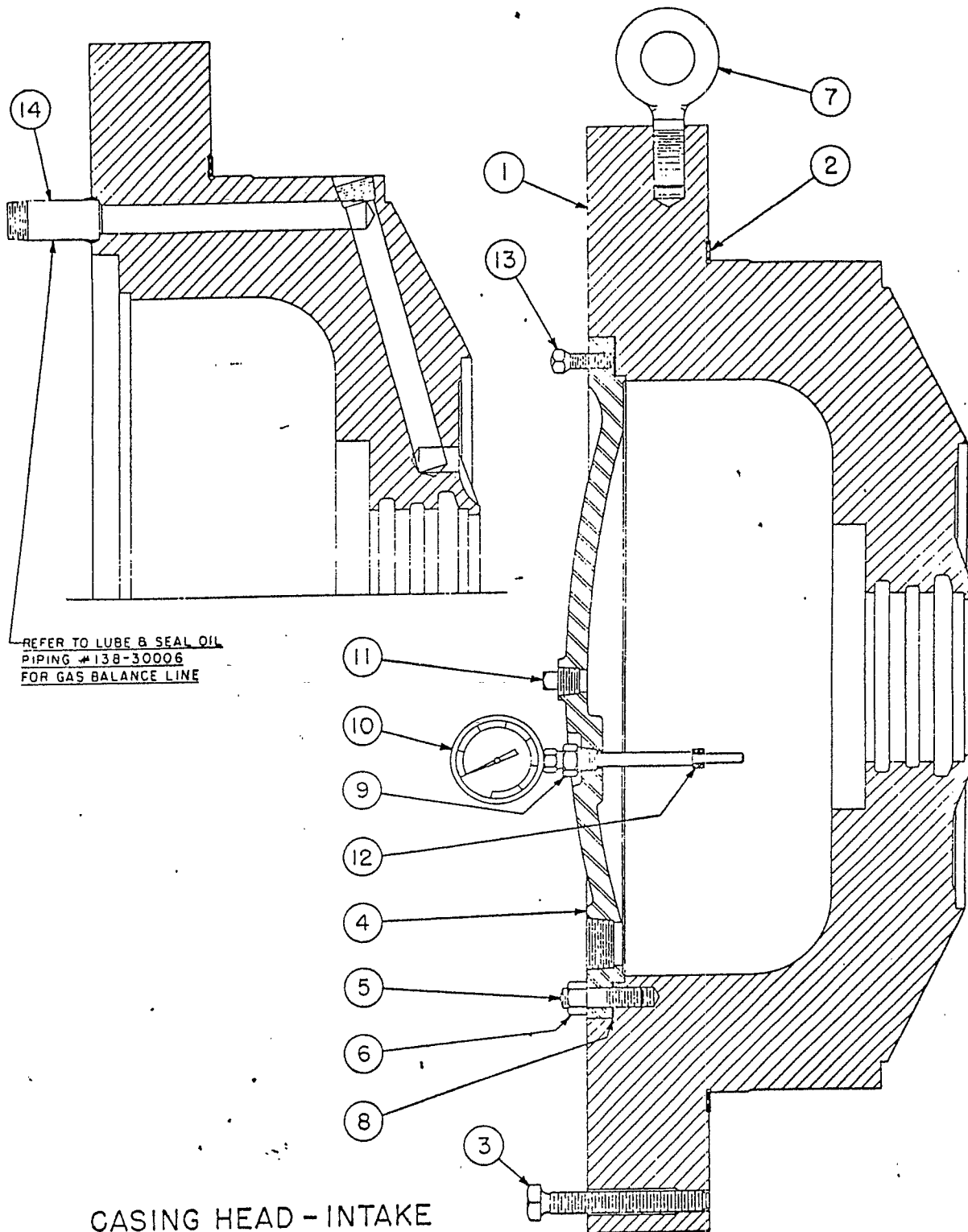


DISCHARGE HEAD

PB-1633

<u>Item No.</u>	<u>Part</u>
1	Discharge Head
2	Discharge Head End Cover
3	Stud
4	Nut
5	Setscrew
6	Setscrew
7	Thermometer 12" Stem with Separable Socket
8	Gasket - Flexitallic
9	Gasket - End Cover
10	Shaft Seal Labyrinth
11	Baffle
12	Fill Hd. Screws Socket Head (Baffle)
13	Shaft Seal Labyrinth Gasket
14	Discharge Volute
15	Screw - Locking Plug
16	Capscrew
17	Balance Piston Labyrinth
18	Labyrinth Ring
19	Steel Nipple
*	Fillister Head Machine Screw
*	Dowel-End Cover
	*Not Shown on Drawing

LTS:mkw:12-3-75



CASING HEAD - INTAKE

— CLARK BROS. CO. —

PB-1634

CHEV B8 6569

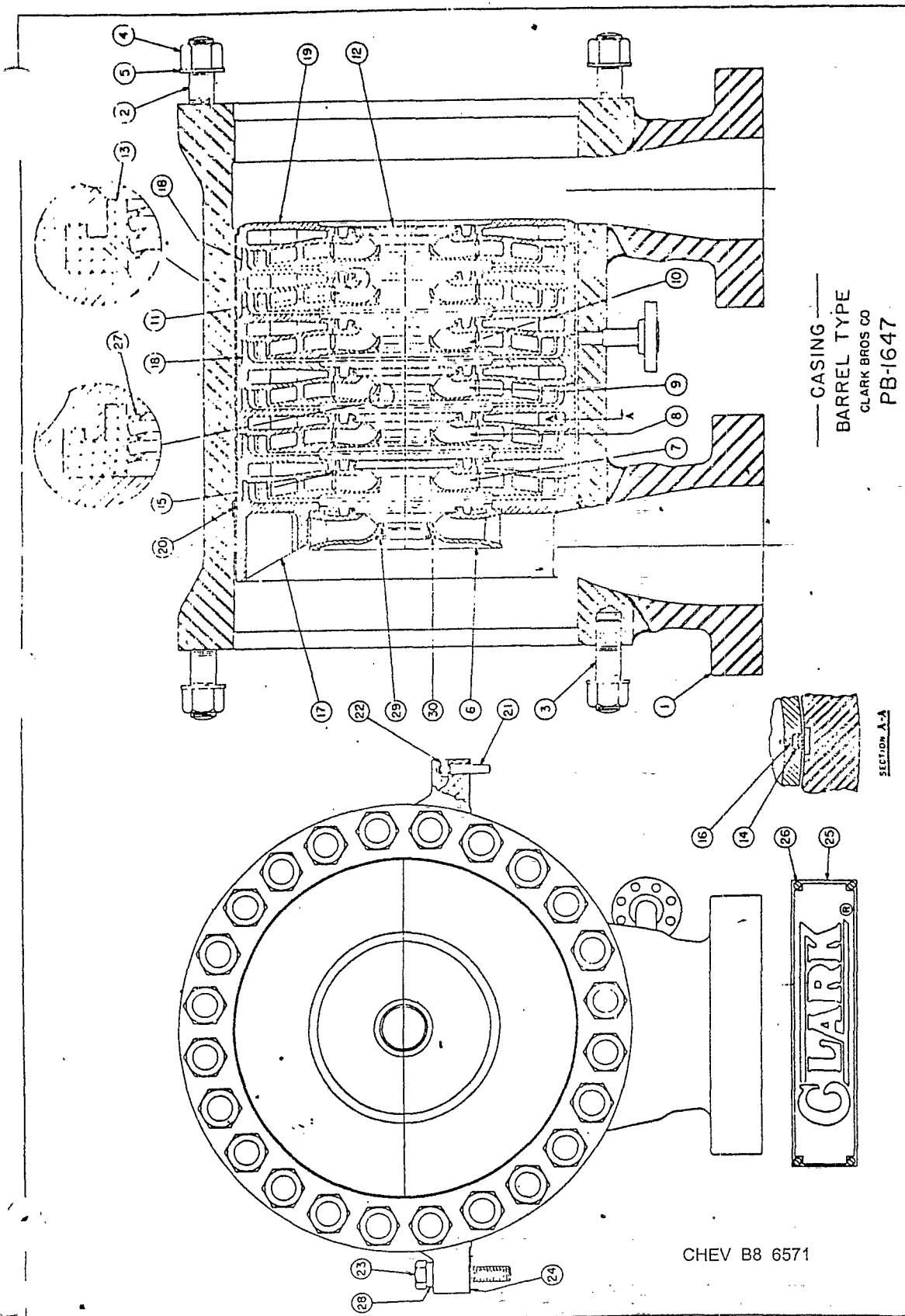
CASING HEAD INTAKE

PB-1634

<u>Item No.</u>	<u>Part</u>
1	Casing Head - Intake
2	Gasket Flexitallic
3	Setscrew
4	Casing Head End Cover
5	Cover Stud
6	Nut
7	Eyebolt
8	Gasket - Casing Head End Cover
9	Separable Socket
10	Thermometer
11	Pipe Plug
12	Thermometer Bushing
13	Setscrew
14	Steel Nipple

LTS:mkw:12-3-75

CHEV B8 6570



— CASING —
 BARREL TYPE
 CLARK BROS CO
 PB-1647

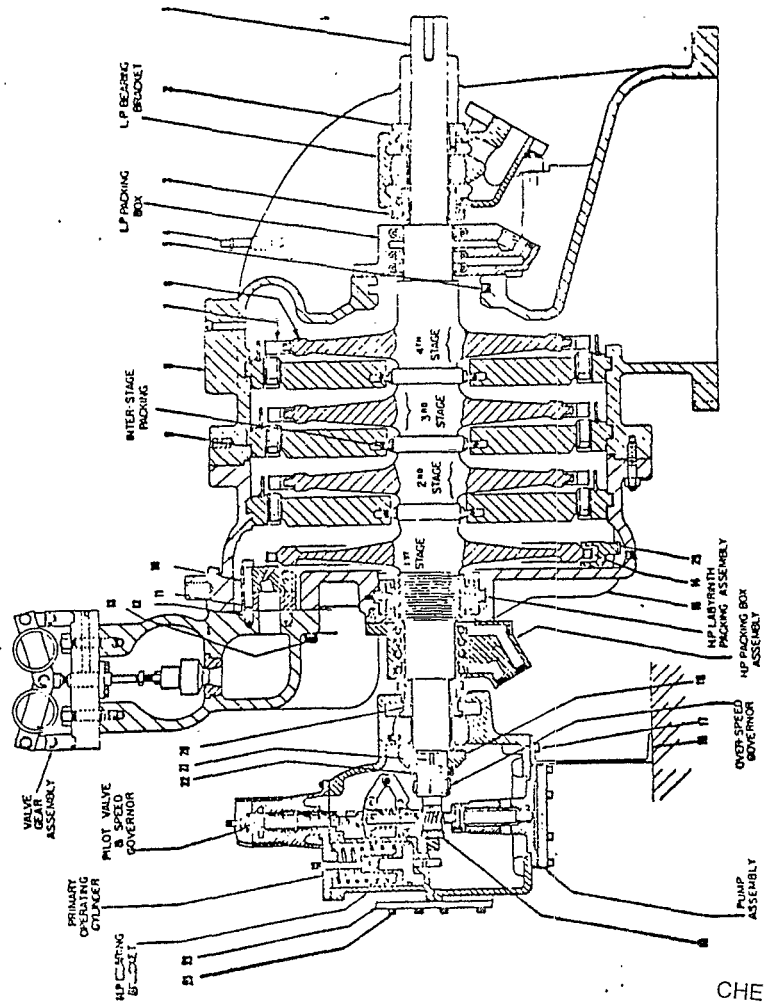
CASING #3-7 STAGE BARREL TYPE COMPRESSOR

PB-1647

<u>Item No.</u>	<u>Part</u>
1	Casing
2	Head Studs
3	Head Studs
4	Nuts
5	Washer for 3" Studs
6	Inlet Guide 1st Stage Agst
7	Inlet Guide 2nd Stage Rad.
8	Inlet Guide 3rd Stage Rad.
9	Inlet Guide 4th Stage Rad.
10	Inlet Guide 5th Stage Rad.
11	Inlet Guide 6th Stage Rad.
12	Inlet Guide 7th Stage Rad.
13	Labyrinth Ring - Large
14	Internal Assembly Key
15	Dowel Pin
16	Machine Screw
17	Inlet Wall "E" Impeller
18	Sawtooth Diaphragm Between 1st & 2nd , 2nd & 3rd, 3rd & 4th, 4th & 5th Stages
19	Sawtooth Diaphragm Last Stage
20	"O" Ring
21	Full Dowel
22	Nut
23	Bolt
24	Compressor Foot Shim
25	Name Plate
26	Parker Kalon Drive Screw
27	Labyrinth Ring - Small
28	Washer - Compressor Foot
29	1st Stage Inlet Guide Labyrinth
30	Screw Cap (1st Stage Inlet Guide Labyrinth)

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CHEV B8 6572



- 1 TURBINE SHAFT
- 2 OIL DEFLECTOR
- 3 OIL DEFLECTOR & BALANCING RING
- 4 SENTINEL VALVE
- 5 RING KEY
- 6 BUCKET WHEEL
- 7 BUCKET
- 8 EXHAUST CASING
- 9 NOZZLE DIAPHRAGM
- 10 NOZZLE PLATE
- 11 NOZZLE PLATE SPACER
- 12 SOCKET HEAD CAP SCREW
- 13 SOCKET HEAD CAP SCREW
- 14 BUCKET (1ST STAGE)
- 15 H.P. CASING
- 16 THRUST COLLAR
- 17 SOCKET HEAD CAP SCREW
- 18 H.P. SUPPORT
- 19 LOCK NUT & WASHER
- 20 THRUST RUNNER, OIL DEFLECTOR & BALANCING RING
- 21 KEY FOR (THRUST COLLAR)
- 22 LOCK NUT & WASHER
- 23 END COVER
- 24 SOCKET HEAD CAP SCREW
- 25 SHROUD

10450003

FIG. 1 TURBINE ASSEMBLY

HOW THE DRV GOVERNOR OPERATES

C-400A&B COMPRESSOR

The DRV governing system is a double relay hydraulic servomechanism. The flyweight mechanism, geared to the turbine shaft, adjusts the position of a pilot valve which controls the oil pressure in the primary hydraulic cylinder. The primary hydraulic cylinder actuates a secondary pilot valve, which in turn controls the position of a secondary hydraulic operating piston connected to the governing valves through a mechanical linkage. In this manner, power amplification is obtained to insure more than adequate force to accurately position the valves and provide sensitive governing.

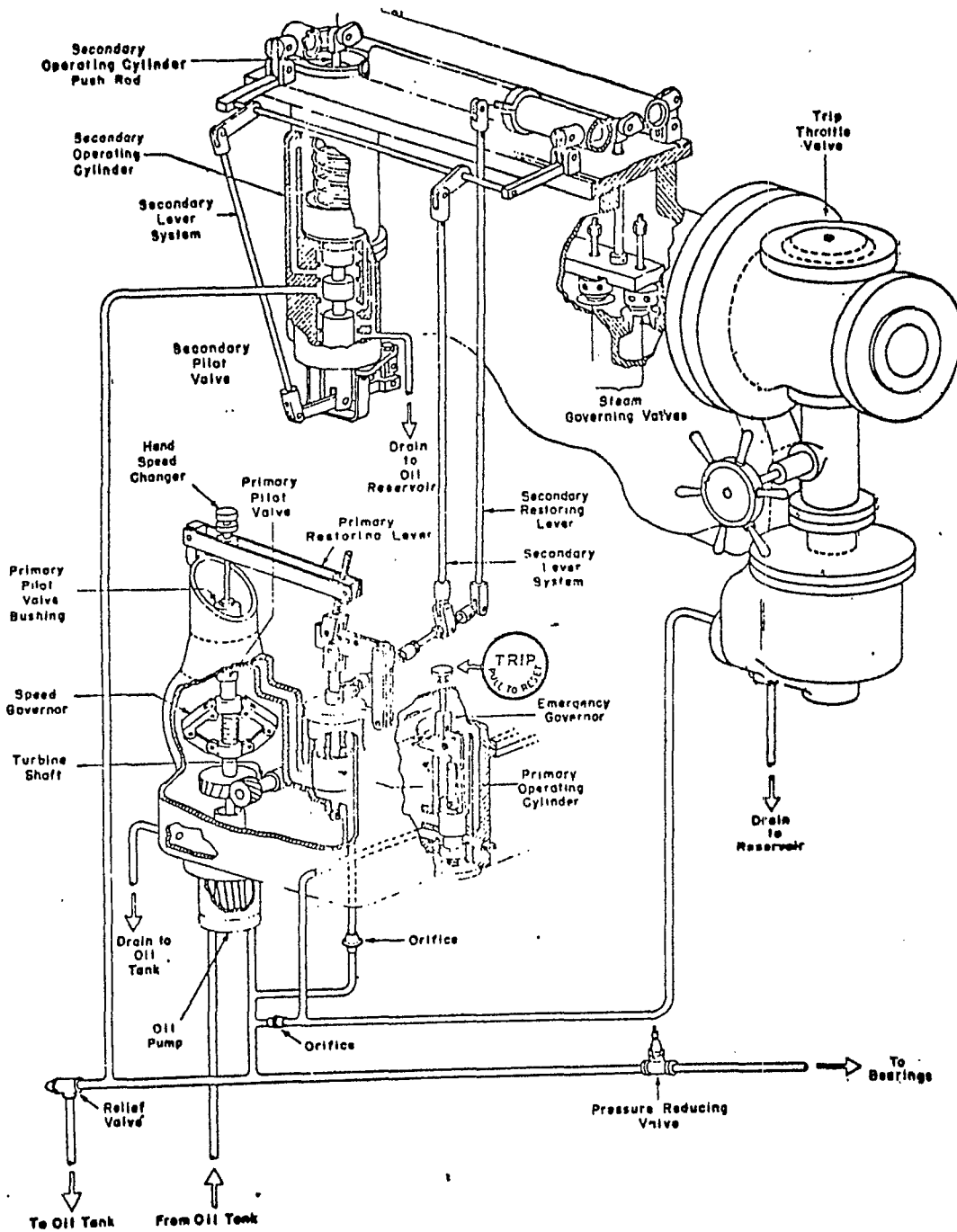
Oil is supplied at constant pressure to the hydraulic system by means of a positive displacement oil pump driven by the turbine shaft through gearing, or by means of an auxiliary motor or a steam driven oil pump. This oil is used to supply lubrication for the bearings and gears as well as to supply hydraulic power for the governing system.

The hydraulic power oil is supplied to the system through the metering orifice. The flyball speed governor, driven by the turbine shaft, positions the pilot valve and establishes a relative ratio between the orifice feed area and the pilot valve drain area. This area ratio establishes oil pressure to the operating piston. If the speed increases, the governor weights move out, drawing the pilot valve downward. The pilot valve movement drains oil away faster than this orifice can furnish it and oil flows from the primary piston toward the pilot valve, lowering the pressure under the primary piston, and causing it to move downward. When the primary piston moves downward, the secondary pilot valve is also moved downward through a mechanical linkage system. This increases the oil pressure on the upper side of the secondary operating piston and decreases the oil pressure on the lower side. The secondary operating piston then moves down which closes the steam control valves through the mechanical linkage between the piston and the valves. Upon a drop in turbine speed the system acts in reverse.

As both the primary and secondary pistons assume new positions, they adjust the position of a bushing located around the primary pilot valve to modulate the pilot valve drain area in such a manner as to oppose the initial change. This function called "restoring" prevents speed or load overshoot and results in stable governing.

GENERAL ELECTRIC COMPANY

CHEV B8 6574



SCHEMATIC DIAGRAM OF GOVERNING SYSTEM OF G-E TYPE DRY MULTI-STAGE TURBINE.

107-5500-10

SMALL TURBINE AND SUPERCHARGER DEPARTMENT

GENERAL  ELECTRIC

CHEV B8 6575

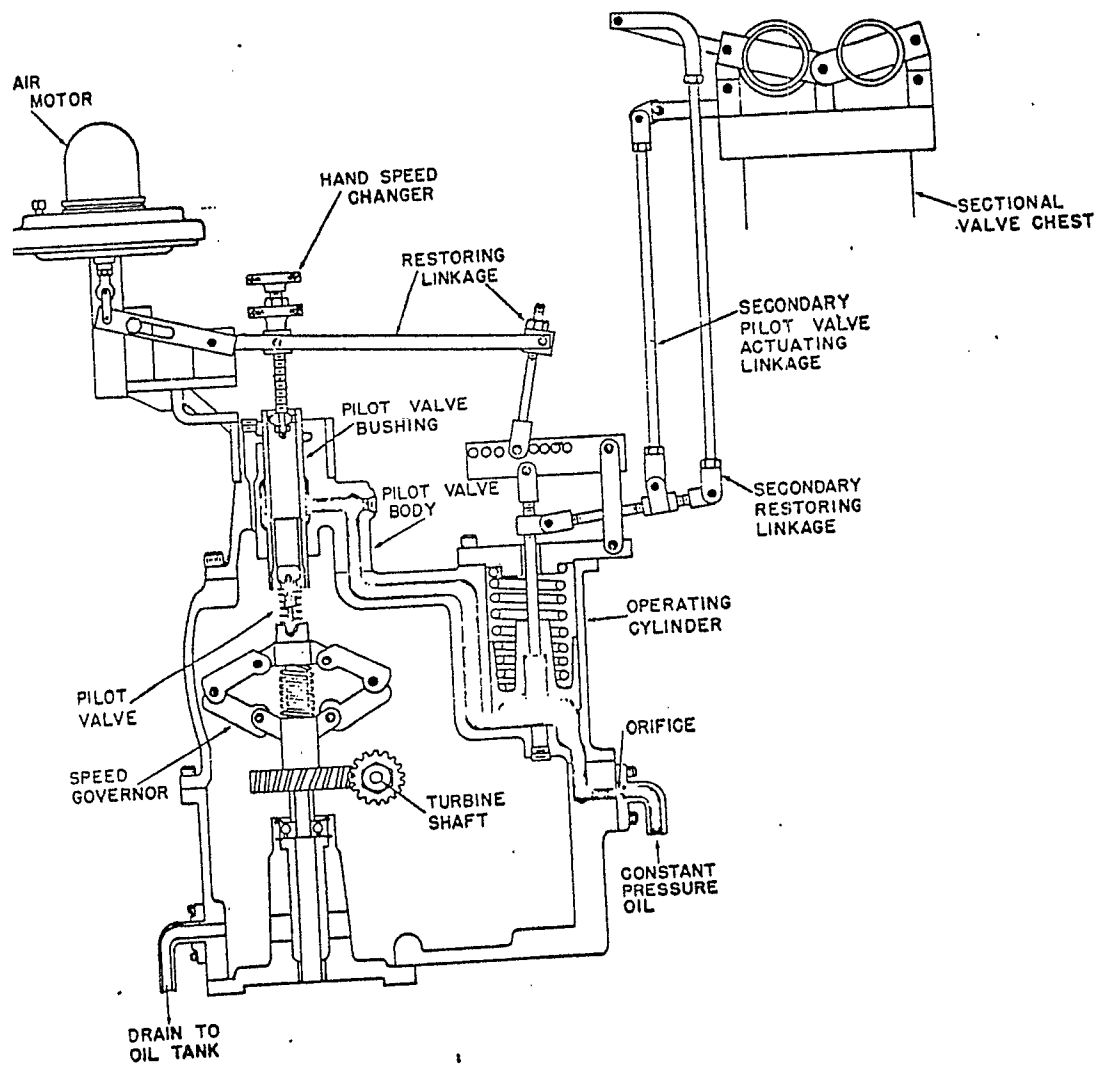
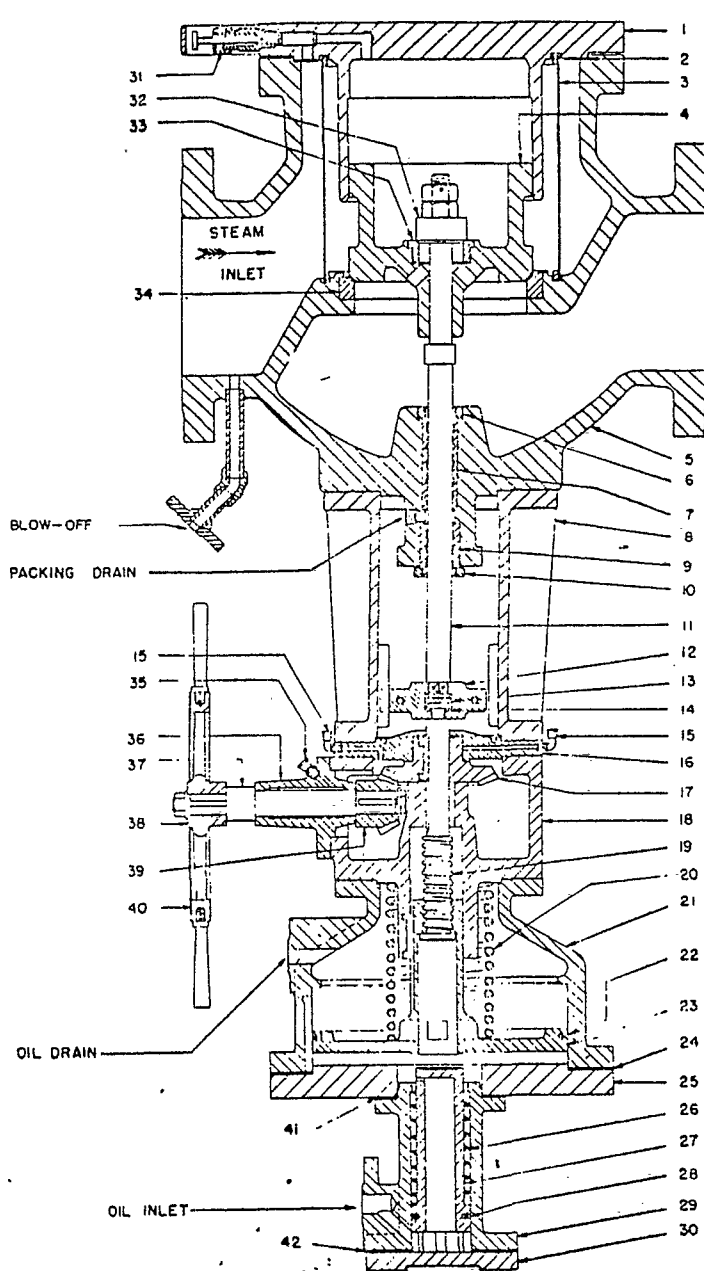


FIG. 1 PRIMARY RELAY

1043220M

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- 1-COMB CYLINDER AND COVER
- 2-GASKET
- 3-STRAINER
- 4-POPPET
- 5-BODY
- 6-BUSHING RET. RING
- 7-BODY BUSHING (LONG)
- 8-YOKE
- 9-BODY BUSHING (SHORT)
- 10-BUSHING RET. PLATE
- 11-VALVE STEM
- 12-COUPLING
- 13-THRUST WASHER
- 14-SPINDLE WASHER
- 15-OIL CUP (ANGLE)
- 16-GEAR SPACER
- 17-BEVEL GEAR
- 18-GEAR HOUSING
- 19-SPINDLE
- 20-SPRING
- 21-OIL CYLINDER
- 22-PISTON RING
- 23-PISTON
- 24-GASKET
- 25-CYLINDER COVER
- 26-PILOT VALVE SPRING
- 27-PILOT VALVE PISTON
- 28-PILOT PISTON RING
- 29-PILOT VALVE CYLINDER
- 30-PILOT VALVE COVER
- 31-ADJUSTABLE SCREW ASSEMBLY
- 32-PILOT POPPET
- 33-PILOT POPPET SEAT
- 34-BODY RING
- 35-OIL CUP (STRAIGHT)
- 36-PINION GUIDE COVER
- 37-PINION SHAFT
- 38-HANDWHEEL
- 39-BEVEL PINION
- 40-NAMEPLATE
- 41-GASKET
- 42-GASKET

CHEV B8 6577

OIL OPERATED TRIP THROTTLE VALVE (A 8 M 3881-F)

W3349718

LUBE OIL SYSTEM C-400A&B COMPRESSORS

As can be seen by reference to the oil piping diagram, oil for governing and lubrication of the turbine and driven equipment is furnished by an electric driven oil pump. An auxiliary turbine driven oil pump is connected as shown in the diagram for the purpose of raising oil pressure in the system and for starting if the main electric driven oil pump is inoperative, or in the event the main oil pump fails to maintain the required pressure. These pumps draw oil from the Lube Oil Reservoir and deliver it under pressure to the governing system of the turbine and lubrication systems of both turbine and driven equipment.

From the discharge of the lube oil pump the oil flows to the governor or through twin coolers, then twin filters and then to the journal and thrust bearings of the compressor and turbine. After the oil emerges from the bearings, it is collected in the bottom of the bearing chambers and drained back to the Lube Oil Reservoir.

The pump and bearing pressures can be checked by means of pressure gages inserted in the lines. The main pump pressure is held at 55 PSIG by a back pressure regulator located before the twin coolers. This is the pressure of the oil supplying the governor. The pressure of the lube oil to the compressor bearings is held at 20 to 23 PSIG by a back pressure regulator that dumps excess oil back into the reservoir. The lube oil to the turbine bearings is held at 12 to 14 PSIG by a pressure reducing valve located before the bearings.

Lube Oil Alarm Signals And Switches

1. Low lube oil pressure set to alarm and start auxiliary lube oil pump at 12 PSIG decreasing pressure. Set to trip turbine at 8 PSIG decreasing pressure.
2. Low turbine bearing pressure set to alarm at 6 PSIG and to trip turbine at 4 PSIG decreasing pressure.
3. Alarm sounding when auxiliary lube oil pump starts.

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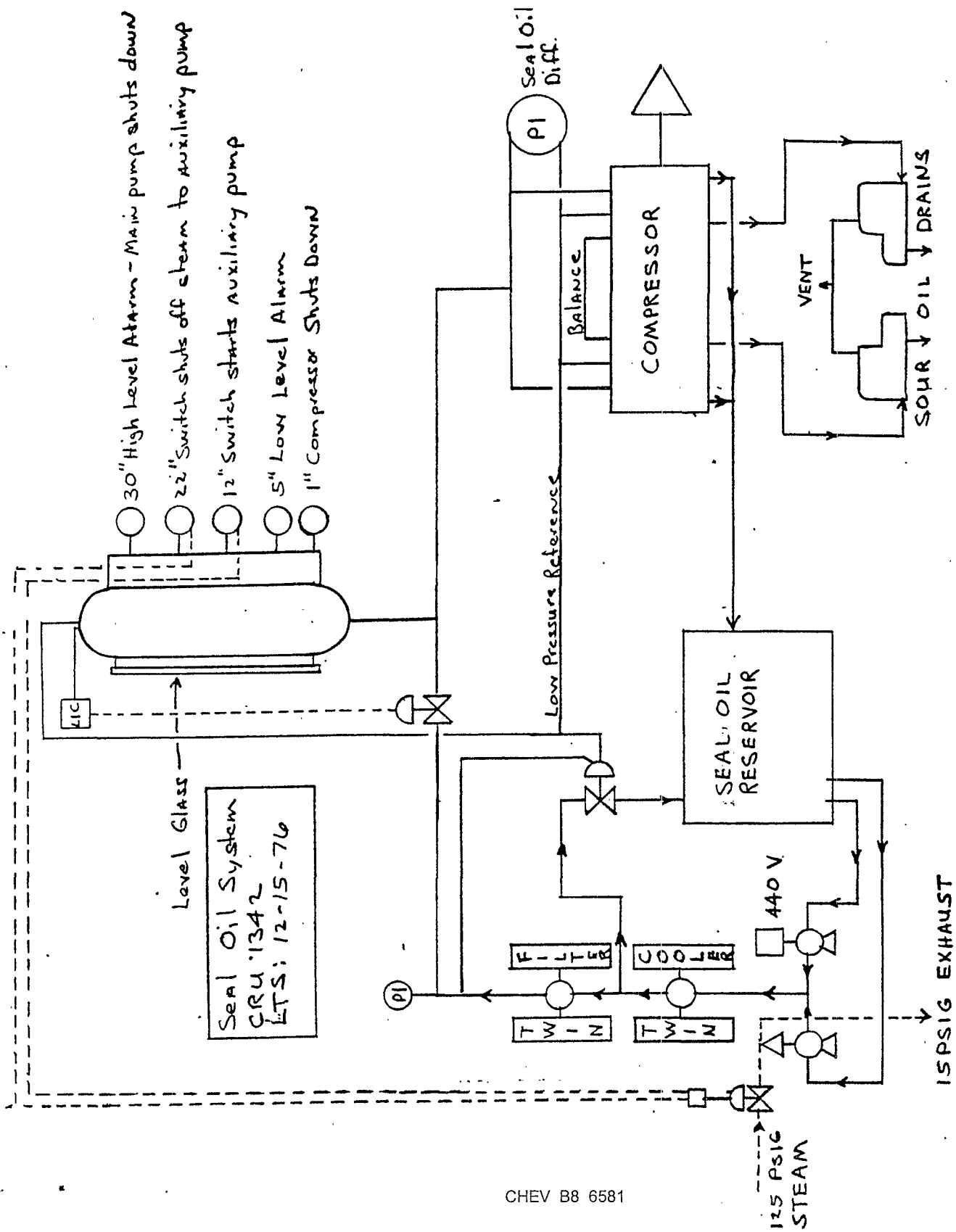
Seal Oil System C-400A&B Compressors

The sealing system acts as a gas tight seal between the compression chamber and the bearing chamber. A further result is the complete absence of contamination of the lube oil by the gas being handled.

The seal oil pump receives its suction from the Seal Oil Reservoir. From the pump, the seal oil flows through the Seal Oil Coolers to a pressure controller which maintains a pressure about 100 psig above the compressor inlet pressure by dumping excess oil back to the reservoir. From the coolers, the oil also flows through the Seal Oil Filters to a level controller that holds a level in the Seal Oil Tank. When the level in the Seal Oil Tank falls below 12 inches, the auxiliary seal oil pump is automatically started. If the level continues to fall a low level alarm sounds at 5 inches of level. When the level falls to 1 inch in the tank, the compressor will be automatically shutdown. This is done by an electrical signal sent from the magnetrol on the seal oil tank which energizes a solenoid operated valve in the lube oil pressure line to the trip throttle valve operating cylinder. When energized, the valve dumps the oil from the cylinder back to the reservoir, thus shutting down the compressor. If the level rises to 22 inches the steam is shut off to the auxiliary seal oil pump. If the level continues to rise to 30 inches, a high level alarm sounds and the main electric seal oil pump shuts down.

The seals are located within the case at the point where the shaft enters the compression chamber from the bearing chamber. The oil entering the seals flows in two directions; inward toward the compression chamber, and outward into the bearing chamber. The oil flowing inward forms a gas-tight seal between the stationary seal sleeve and the rotating shaft. This oil ultimately reaches a row of drainage ports which are channeled into a seal oil drain line to the sour oil traps. The oil flowing outward into the bearing chamber is returned to the reservoir.

LTS:mkw:12-30-76



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C-500 A B B C

CENTRIFUGAL PUMPS

The simplest type of centrifugal pump is the single stage machine which consists fundamentally of a rotating element, called an impeller, and a casing. Liquid is led to the eye or center of the impeller and is set into rotation by the impeller vanes. By virtue of centrifugal force the liquid is thrown from the rim or periphery of the impeller with a considerable velocity and pressure. The casing which closely surrounds the impeller, has a volute shaped passage of increasing area which collects the liquid leaving the impeller and converts a portion of its velocity energy into additional pressure energy. This casing passage leads to the discharge nozzle of the pump from which piping conducts the liquid to its place of use.

Regulation and Characteristics

Pressure and volume delivered by a centrifugal pump are best controlled by throttling the discharge valve, provided the pump is driven by an electric motor. If the pump is driven by a steam turbine, it is best to throttle the steam to the turbine. Less steam is used and better efficiency results, except at very low rates.

Because most centrifugal pumps are run by electric motors at constant speed, it is customary for the pump manufacturer to test each pump, and to supply the customer with a set of test curves which show the effect of throttling the discharge valve on the performance of the pump. Figure 9 shows a typical set of curves. The graph has its horizontal scale divided off in barrels per hour volume delivered by the pump. The vertical scale at the left shows pump pressure either in psi or in feet of water head. Water is used as the test medium because it is always readily available.

The curves are called "characteristic curves" because they show the character of the pump no matter how it is operated, as long as two conditions are present: (a) it is handling the stock used in the test (water in this case) and (b) it is operating at the test speed (3500 rpm in this case). For newer pumps, the curves are included in the plant photostat books. These curves tell the operator what to expect from the pump.

The head capacity, or pump pressure curve, is important as it shows the pressure is maximum at shutoff. This curve also shows that the pressure drops off as flow is increased by opening the discharge valve. With the valve wide open the flow is maximum for the resistance in the piping. If resistance of the piping system is gradually removed, the volume will increase and pressure decrease to a point called the "cutoff". At cutoff, the volume is maximum and pressure quickly drops to zero. For other stocks and other speeds, the shape of the curve is the same. Higher viscosity shifts it down; higher gravity shifts it up. Throttling the steam to slow down a turbine drive shifts the head capacity curve down. It also shifts the power curve down, which is an advantage.

If the scale values in psi are divided by 0.43, which is the pressure exerted by one foot of water, the result is head in feet. If the head (in feet) is multiplied by 0.43, the result is pressure in psi when pumping water. The head (in feet) indicates how far the stock would rise in a standpipe on the discharge of the pump. The head (in feet) is the same regardless of the gravity of the stock. It depends on the speed with which each drop is thrown from the impeller. Consider two balls of the same size. A lead ball spun on a string will go the same distance or just as high in the air as a steel ball for the same speed, but the lead will hit harder, giving more pounds of pressure. Likewise, gasoline in a standpipe on the discharge of the centrifugal pump will rise to the same height as water; but psi pressure at the bottom of the pipe will be more for water because it is heavier.

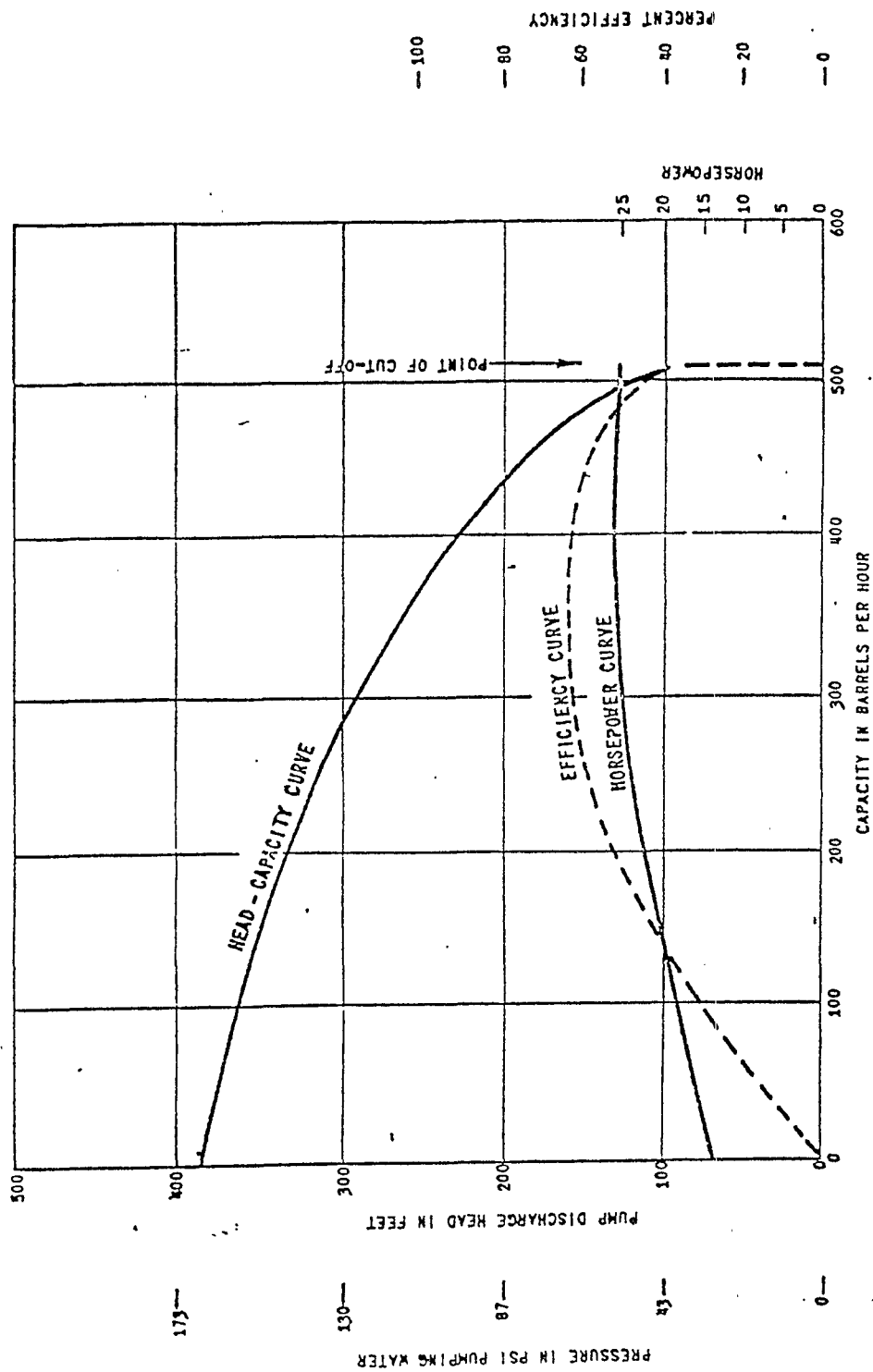
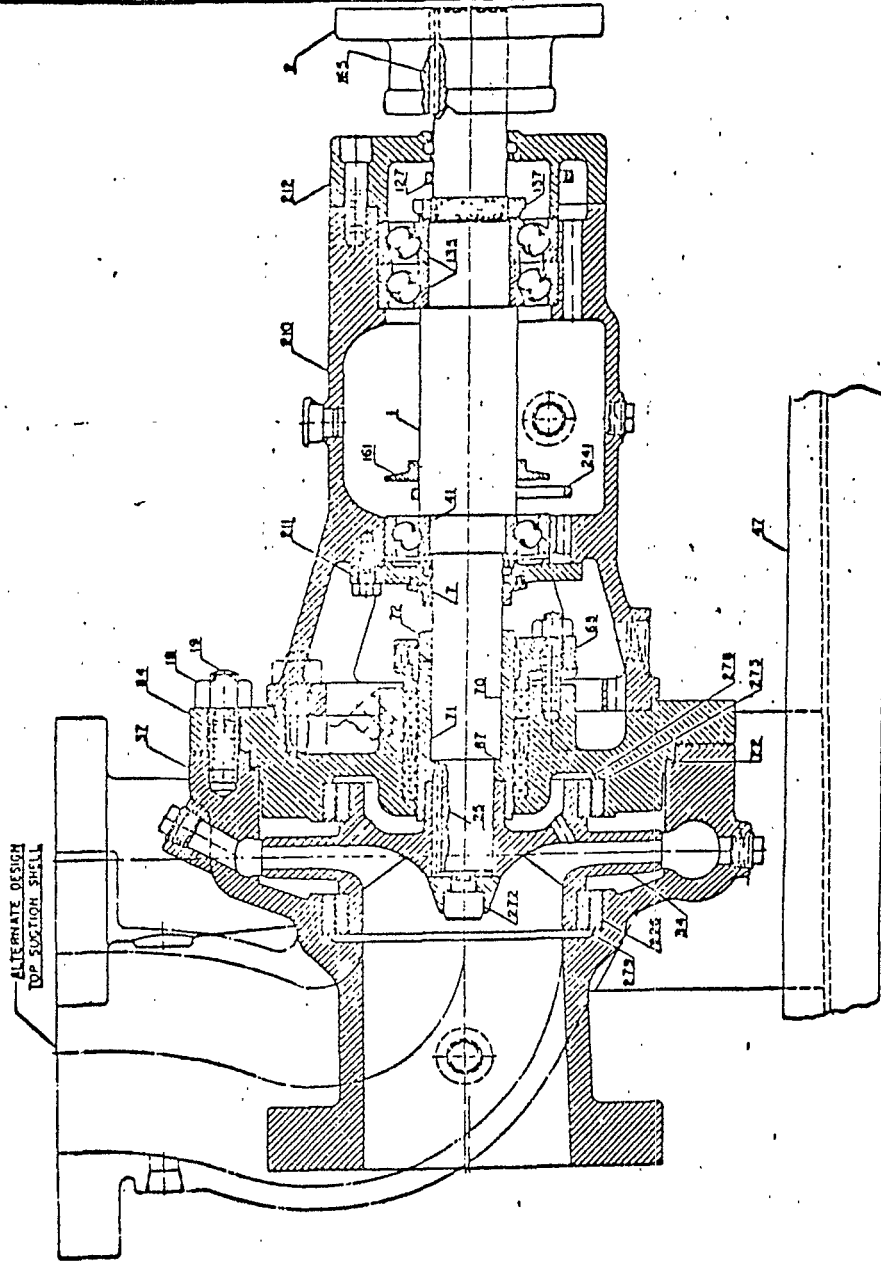
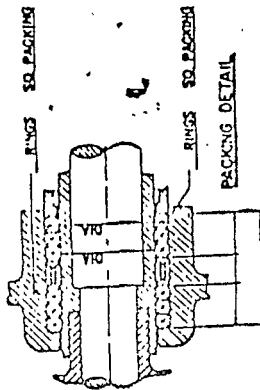


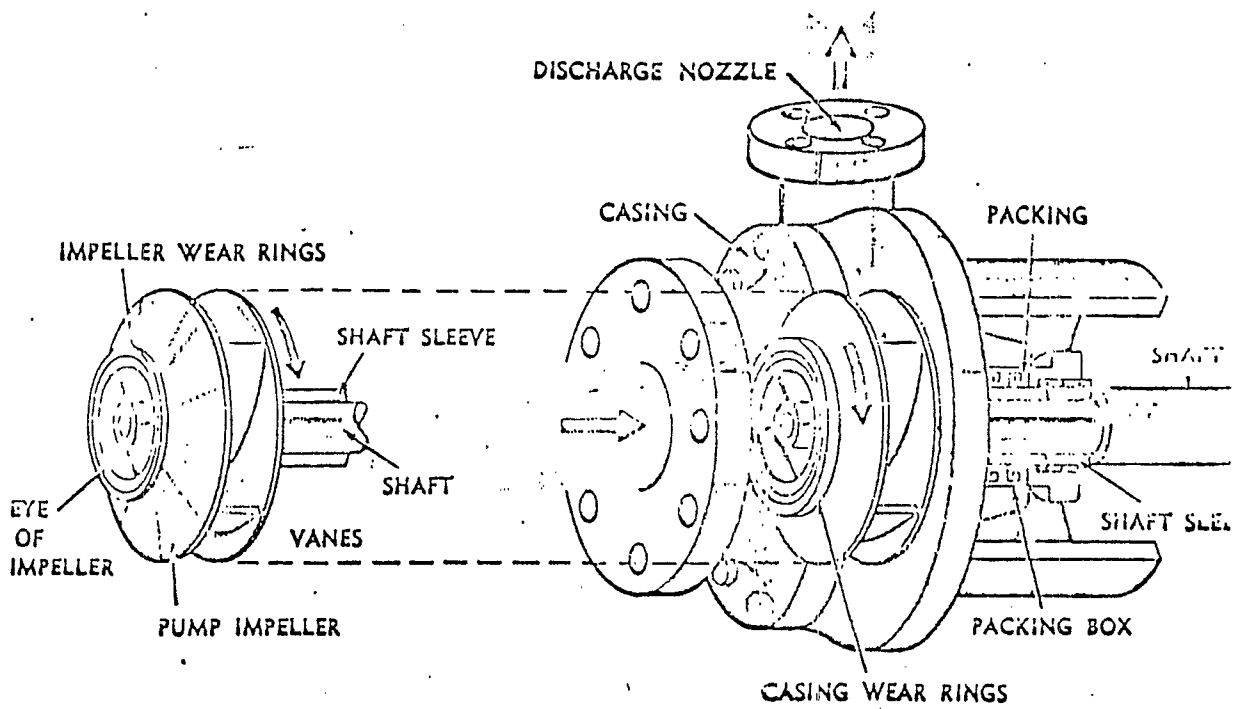
Figure #9
TYPICAL CHARACTERISTIC CURVES

Centrifugal Pump



Q	NAME OF PART
1	FLANGE CAST
2	FLANGE COUPLING
3	COUPLER RING
4	SHIELD NUT
5	SHELL STUD
6	HEAD GASKET
7	IMPELLER KEY
8	IMPELLER
9	IMPELLER BALL BEARING
10	IMPELLER WASHER
11	IMPELLER LOCKNUT & WASHER
12	IMPELLER RING
13	IMPELLER RING WEARING RING
14	IMPELLER RING WEARING RING-HEAD SIDE
15	IMPELLER RING WEARING RING-SHELL SIDE
16	IMPELLER RING WEARING RING-SHELL SIDE
17	IMPELLER RING WEARING RING-SHELL SIDE
18	IMPELLER RING WEARING RING-SHELL SIDE
19	IMPELLER RING WEARING RING-SHELL SIDE
20	IMPELLER RING WEARING RING-SHELL SIDE
21	IMPELLER RING WEARING RING-SHELL SIDE
22	IMPELLER RING WEARING RING-SHELL SIDE
23	IMPELLER RING WEARING RING-SHELL SIDE
24	IMPELLER RING WEARING RING-SHELL SIDE
25	IMPELLER RING WEARING RING-SHELL SIDE
26	IMPELLER RING WEARING RING-SHELL SIDE
27	IMPELLER RING WEARING RING-SHELL SIDE

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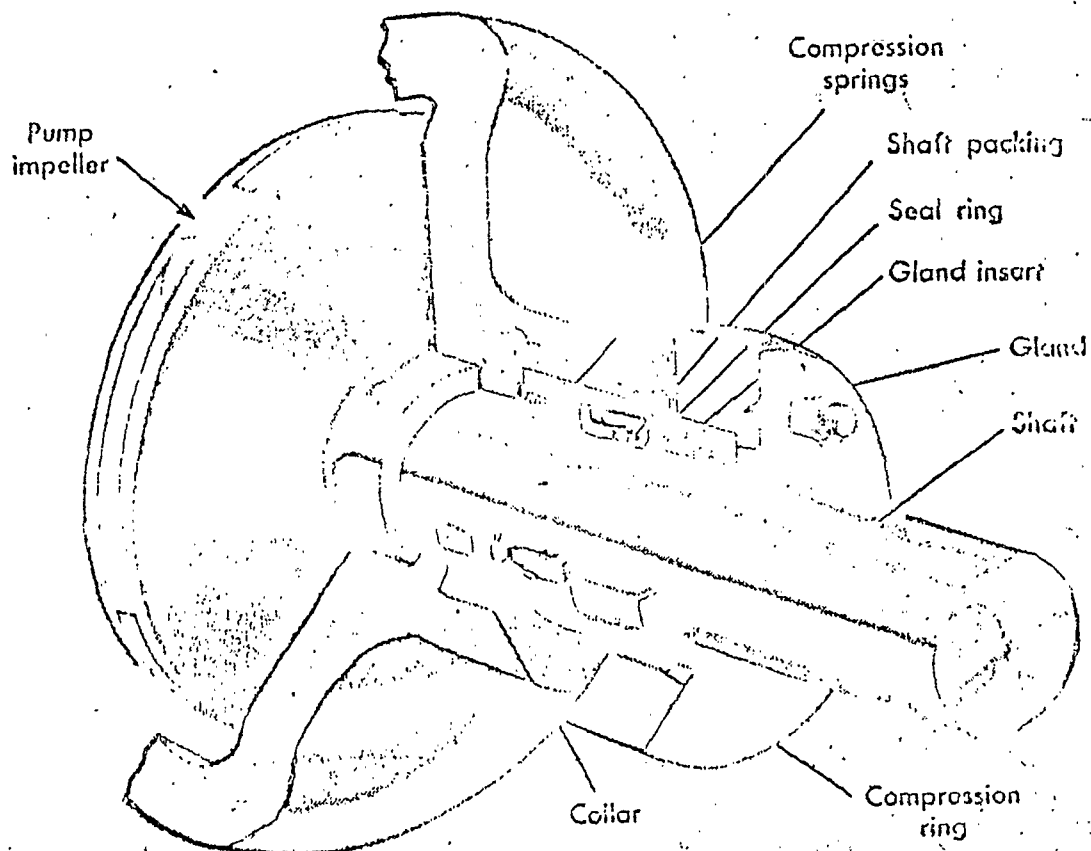


Fig. 5
DURA-SEAL MECHANICAL SEAL

FUNDAMENTALS OF MECHANICAL SEAL OPERATION

MECHANICAL SEAL REQUIREMENTS

Before we determine how a mechanical seal operates, it is necessary to thoroughly understand the nature of the job it is called upon to perform.

Perhaps the most frequently encountered requirement for sealing a rotating shaft is found on a centrifugal pump. Figure I-A illustrates the

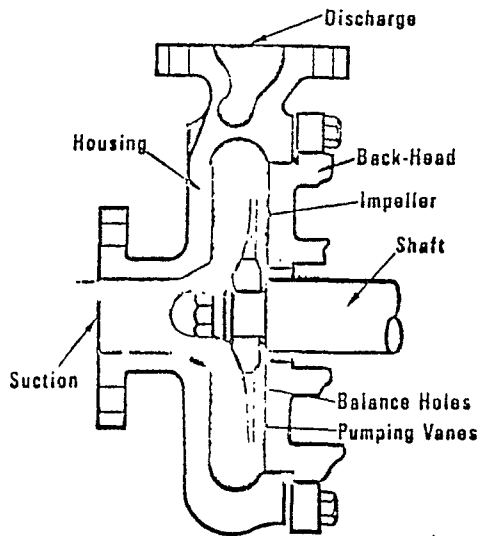


FIG. I-A
CENTRIFUGAL PUMP LIQUID END

liquid end of a typical centrifugal pump. The liquid to be pumped enters the suction inlet at the eye of the impeller. As the impeller rotates, at relatively high speed, liquid occupying the space between the vanes is held captive by the close clearance that exists between the front of the impeller and the pump housing or volute.

Having no other path of escape, the liquid is centrifugally forced to the outside diameter of the impeller where it flows out through the discharge nozzle. At the point of discharge, the pressure of the liquid is many times higher than it is at the suction inlet, which accounts for the centrifugal pump's ability to push liquid to heights far above the pump. This same discharge pressure, however, flows down behind the impeller to the drive shaft which is connected to a driver outside the pump. This is the shaft that must be efficiently sealed if the pump is to be of any practical use.

To make the job of sealing the drive shaft somewhat easier, most pump manufacturers relieve some of the pressure behind the impeller. For example, on an open impeller pump, this is usually accomplished in either one of two ways, or a combination of both. Considering that the clearance between the back of the impeller and the pump back-head is actually much closer than shown in our illustration, small pumping vanes are often placed on the back side of the impeller. Although not as large or as efficient as the vanes on the front of the impeller, these smaller vanes will significantly reduce the pressure of the liquid trying to escape to the atmosphere from behind the impeller. In addition to pumping vanes, balance holes can also be drilled through the impeller to the suction eye, thus relieving the high pressure behind the impeller to the low pressure suction eye of the impeller. By decreasing the pressure differential between the front and rear of the impeller, these methods also greatly reduce the axial thrust on the shaft, thereby prolonging thrust bearing life. Even with the existence of pumping vanes and balance holes, suction pressure, plus usually a small percentage of discharge pressure, always surrounds the drive shaft. Therefore this shaft must be fitted with a reliable seal.

PACKED STUFFING BOX

As pointed out in the introduction, the earliest method conceived for performing the task of sealing a rotating shaft, was to compress some form of resilient material into an extension of the pump back-head, called the stuffing box. This eventually became known as packing.

Figure I-B shows a typical stuffing box sealed with square rings of compression packing. If this packing were to rub against the shaft, without lubrication present to prevent a build-up of

amount of lubrication. When this flow of lubrication exits from the packing, it becomes identified as leakage.

Other inconveniences associated with packing are adjustment and sleeve or shaft wear. It has already been suggested that because of certain irregularities, a particular ring of packing is periodically in contact and out of contact with the shaft. When the packing wears, or loses its resiliency, leakage increases. The packing must then be adjusted to bring the leakage under

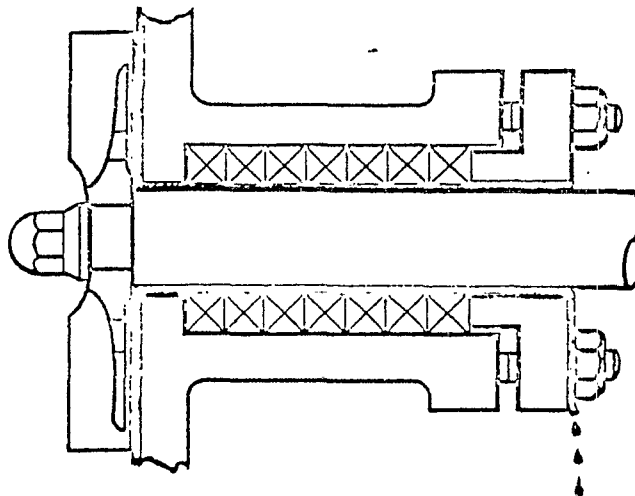


FIG. I-B TYPICAL STUFFING BOX WITH COMPRESSION PACKING

frictional heat, it would soon destroy itself. Therefore, a certain amount of the liquid being pumped—or some other liquid injected at high pressure from an outside source—must be allowed to flow between the packing and the shaft, as shown in Figure I-B. Because of the surface irregularities of packing, eccentricity between the stuffing box bore and the shaft, as well as normal shaft run-out, a significant amount of packing must be used to compensate for these irregularities. It is this generous amount of packing that requires a proportionately generous

control. This is a continuing maintenance program that can be easily measured in terms of dollars and cents.

These same irregularities also exert uneven pressure on the shaft and restrict lubrication flow at certain locations, producing wear on the shaft or shaft sleeve. When this wear has been allowed to become acute, stuffing box leakage increases drastically. The only solution to reducing the leakage is to incur the expense of a new or repaired shaft or shaft sleeve.

The best method of packing adjustment is to take up one flat on each side of the gland nut and wait a few minutes, allowing time for packing to refit itself to the shaft. After adjustment, the gland should be snug but still feel "live" and springy, not jammed in hard. When the gland is fully tightened it is time to remove all the old packing and full repack the pump. Adding a ring or two of new packing on top of the old can lead to chewing up the shaft sleeve. If the packing runs hot, an air hose can be used to cool the exterior of the stuffing box when breaking in new packing. Water hoses should not be used for this purpose, as they frequently cause water to get into the bearings.

Cavitation

All throttling of centrifugal pump should be done on the discharge and never on the suction line, to prevent cavitation. Cavitation is the formation of small bubbles of vaporized stock in the casing, followed by the violent collapse of these bubbles as they pass through the impeller, where pressure is suddenly increased. If the suction pressure gets below the vapor pressure of the stock at that temperature, vapor is formed. Often a noisy, growling sound is made by collapsing bubbles as they reach the area of high pressure.

It is estimated that, at the point of collapse, impact pressures of the order of 25,000 psi occur. Bits of metal are picked up from the surface of the impeller where the bubbles collapse. In time the impeller can be completely chewed away by cavitation. Cavitation has other bad effects. When cavitating, the impeller may be slammed up and down or back and forth by hydraulic unbalances. This can result in ruined packing, damaged shaft seals, burned-out bearings, and seized wear rings. The operator should look for cavitating conditions, before these troubles are experienced.

Pulling Air into the pump or losing suction can cause an effect similar to cavitation. Although lost suction may not cause pitting, the hydraulic unbalances created are even worse with regard to damaged bearings, packings, and seals. If left untended, a pump with lost suction will overheat, causing wear rings to seize and ultimately ruin the pump. He should operate at all times with the suction wide open and the discharge pinched back to where the pump case stays full of liquid and cavitation is avoided.

Preventative Maintenance

Preventative maintenance is necessary to insure proper operation of pumps, with a minimum of repairs. Reminders for ways of reducing repair costs, improving start-up and operation, and watching for danger signals are included in Figures 6 and 8

A SIMPLE MECHANICAL SEAL

Now that the problems associated with packing have been defined, let's see how a mechanical seal operates, and then, how it overcomes the objections to packing.

Figure 1-C shows the parts of a simple mechanical seal. The coil spring, "O" ring shaft packing, and seal ring fit over the shaft and rotate with it. The spring can be made from any one of a number of materials. The selection of the material depends upon the corrosion resistance required to withstand attack from the product being pumped. Similar considerations are evaluated when selecting the "O" ring shaft packing material and seal ring material. The insert and insert "O" ring mounting are fitted into a bore provided in the gland ring. This entire assembly is then attached to the pump stuffing box, remaining stationary as the shaft rotates. The insert is made from carbon graphite which offers

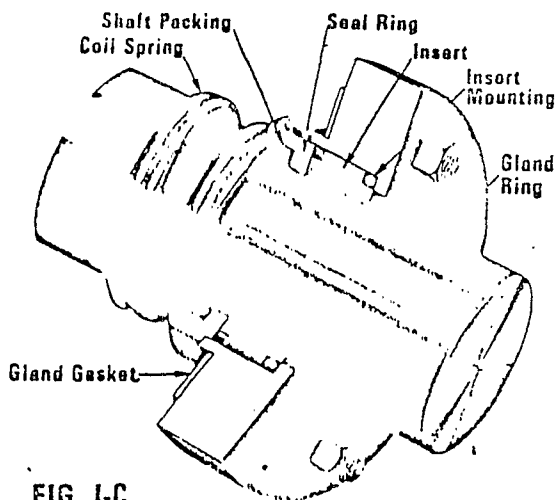


FIG. 1-C
A SIMPLE MECHANICAL SEAL

a good bearing surface for a variety of seal ring materials to rotate against, and is inert to corrosive attack by most chemicals at a wide range of temperatures.

Figure 1-D shows this simple seal completely assembled in the pump stuffing box. The coil spring rests against the back of the pump impeller, pushing the seal ring forward so that it

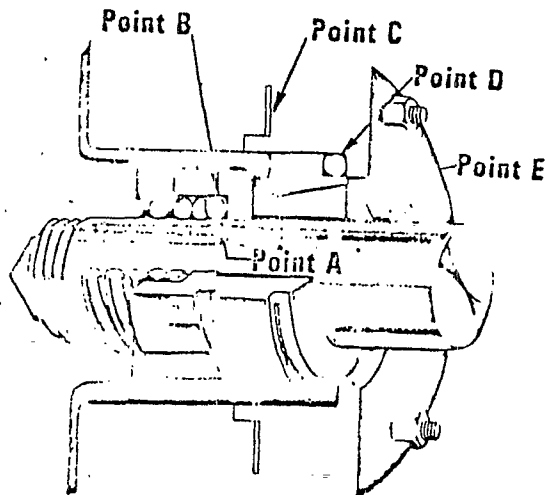


FIG. 1-D
STUFFING BOX WITH MECHANICAL SEAL

remains in intimate contact with the stationary pump shaft insert. Friction between the rotating pump shaft and shaft packing causes the seal ring to rotate with the shaft. Friction between the spring and the impeller, as well as the spring and the compressed "O" ring, is responsible for the spring rotating with the seal ring and shaft packing. The insert is positioned within the gland bore. The gland itself is bolted to the face of the stuffing box. Friction between the "O" ring insert mounting and the I.D. of the gland bore holds this part of the seal stationary as the shaft rotates within the bore of the insert.

SEALING POINTS

With our simple mechanical seal now properly assembled in the stuffing box, let's see how the liquid in the pump is prevented from es-

caping to the atmosphere. The path of the liquid down the shaft is blocked by the "O" ring shaft packing at Point A on Figure I-D. Liquid attempting to pass under the seal ring is blocked by the "O" ring shaft packing at Point B. Liquid attempting to pass over the seal ring is finally blocked from reaching the atmospheric side of the pump by the gland gasket, Point C, and the "O" ring insert mounting Point D. The path of escape remaining is the seam between the rotating seal ring and the stationary insert, Point E. This is where the real secret of the mechanical seal's efficiency lies.

The face of the seal ring and the face of the stationary insert are lapped to a flatness that is measured in millionths of an inch. Therefore, these faces remain in contact throughout their entire contact surface area, thereby providing a nearly positive seal. Just as in the case of packing, the faces must be lubricated, however. After all, these faces are, in a sense, friction bearing surfaces. But because the area of the bearing surface is only a fraction of that encountered with packing, and because the contact pressure is equally distributed throughout the interface, much less lubrication is required. Consequently, a correspondingly smaller amount of lubrication passes between the seal faces to exit as leakage. Whereas most packing depends upon a measurable flow of liquid between it and the shaft for lubrication, the mechanical seal faces ride on a microscopic film of liquid that is able to migrate between them. Indeed it is true that when this film reaches the atmosphere, it can be classified as leakage. This leakage is usually so slight, however, that it will vaporize before it can be visually detected. Where liquids that do not readily evaporate, such as wax, are being sealed, minor accumulations may be detectable under the gland, but only after many hours of operation.

ADVANTAGES OF A MECHANICAL SEAL

We have seen how a mechanical seal offers a much more positive seal than packing. It is im-

portant to note that the mechanical seal also overcomes the other major objections to packing mentioned earlier in this section. Since the spring exerts constant pressure on the seal ring, the mechanical seal automatically adjusts for wear at the faces, thereby eliminating the need for manual adjustment. Also, because the bearing surface is between the rotating and stationary parts of the seal, the shaft or shaft sleeve does not become worn. Only the seal, not the shaft or sleeve, will eventually require replacement. Only a mechanical seal offers the user long maintenance-free and leak-free life. It is not unusual for a mechanical seal to function flawlessly for more than 15,000 hours of operation.

Although a mechanical seal is more difficult to install than packing, it offers many advantages not available in a packed pump.

Wear Rings

The wear rings keep liquid from bypassing inside the case of a centrifugal pump from the discharge back to the suction. The wear rings are installed in pairs, with a pair on each side of the impeller. A matching set of wear rings can be seen on the left impeller in Figure 3 & 4. The clearance between rings is kept small for the sake of efficiency. In a good pump not over 5% of the liquid pumped leaks past the wear rings.

If the clearance is too small, the wear rings may cut and seize, or even ruin the pump. More clearance is needed for hot stocks. Seizing may be caused by unequal thermal expansion or by foreign material in the stock. Some liquid always leaks past the wear rings whenever the pump is operating and in time, as they wear the clearance gets greater. Wear is hastened by gritty material in the stock. In time, so much efficiency is lost that the pump can no longer handle the job and must be shut down for installation of new wear rings.

Centrifugal Pump Bearings

Bearings must support the weight of the shaft and impeller and absorb whip or hydraulic pressures. They must support both radial loads and withstand end thrust due to hydraulic unbalance. Radial and thrust loads may be handled by the same or by separate bearings.

A sleeve bearing consists of (a) the journal, which is smooth surface machined on the steel shaft, and (b) the sleeve, which is a tube of softer material fitted over the journal, and usually split to make it removeable. They are fixed to and rotate with the shaft. Sleeves are usually babbit lined or bronze.

A ball bearing consists of an inner race, an outer race, a set of balls, and a cage or rack to space the balls equally around the races. They are either ring oiled like as shown in Figures 2 & 4 or level oiled. In the level oiled type the oil level is about half way up on the bottom ball. Correct oil level is highly important for this type. If too low, the bearing may run dry and burn out. If too high, the oil will foam, choking up the housing and cause the bearing to overheat and burn out.

The bearing housing must be vented to allow breathing as oil temperature changes. It is also fitted with a filler and inspection hole on top and a drain plug on the bottom. Correct oil level is usually marked on the sight glass. It is regulated by a drip bottle.

The bearing housing is water jacketed and cooling water is piped through the jacket. Water and dirt must be kept out of bearing housings, and should be checked

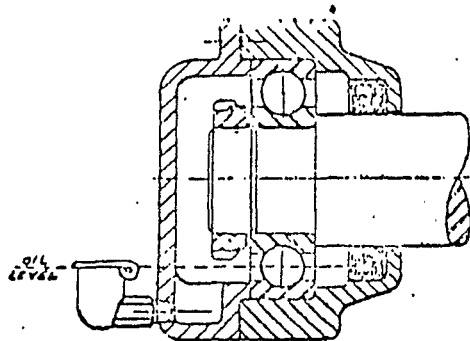


Fig. 2A

Oil Cup Lubrication

In each of the above methods of lubrication, it is important that the proper oil level be maintained. An oil level which is too high or too low can cause or contribute to bearing failures. There are many disadvantages in the use of the common oil cup shown in Figure 2A. Disadvantages of installations utilizing the oil cup and the advantages of constant level oilers are shown in Figure 4A.

In many instances the oil cup has been replaced with a constant level oiler as shown in Figure 4A. When properly installed, the constant level oiler fulfills each of the rules for the selection of a method of oil application to ball bearings.

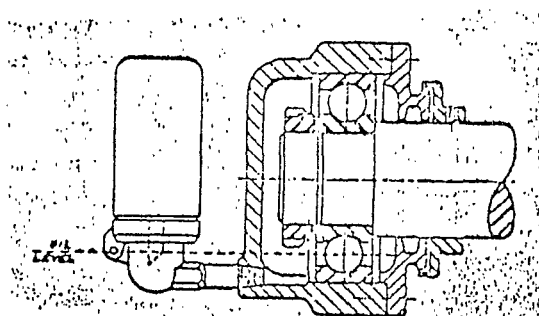


Fig. 4A

Constant Level Oiler

The oiler functions as follows: When the oil level in the reservoir falls, air passes into the bottle and permits oilflow out of the bottle until the air entry is again cut off by the rise of the oil level in the reservoir. The bottle is detached for servicing. The reservoir in the bearing housing should always be filled by emptying the constant level oiler; this insures the proper oil level.

FLEXIBLE COUPLING

When the shafts of two pieces of equipment are coupled to rotate as a unit, precise alignment of the shaft axes is a vital requirement. Even under the ideal conditions of initial assembly or installation, true alignment is difficult to achieve. Consequently, the probability of maintaining accurate alignment is greatly lessened during actual operation of the equipment. Settling of foundations, dimensional changes due to temperature variations, shaft deflection, fatigue of structural members, and many other factors, all contribute to misalignment of coupled shafts.

The repeated flexing of rigidly coupled rotating shafts, however slightly misaligned, can induce serious stresses in the shafts themselves and dangerously overload the shaft bearings. Likewise, undue stresses and overloads are present when normal axial movement of rigidly coupled shafts is constrained. Rapid failure of the equipment is certain under these conditions.

A flexible coupling is the answer to this problem.

It serves as the component means of connecting rotating shafts and, at the same time, it compensates for misalignment and allows for free end movement of the coupled shafts.

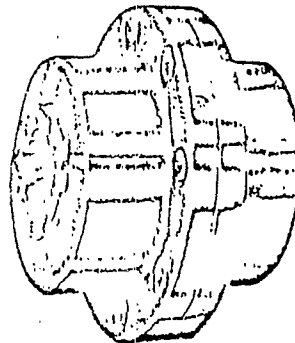
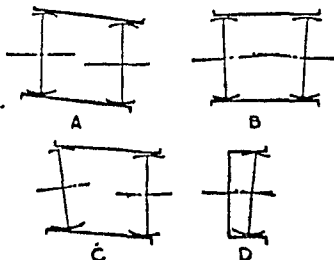
Types of Misalignment

There exist three major types of misalignment associated with coupled shafts:

1. Offset misalignment. Axes of shaft are parallel and offset (see diagram A)
2. Angular misalignment. Axes of shafts intersect at point of coupling (see diagrams B and D)
3. Offset and Angular misalignment. Axes of shafts do not intersect at point of coupling and are not parallel. (see diagram C).

Functions of a Flexible Coupling

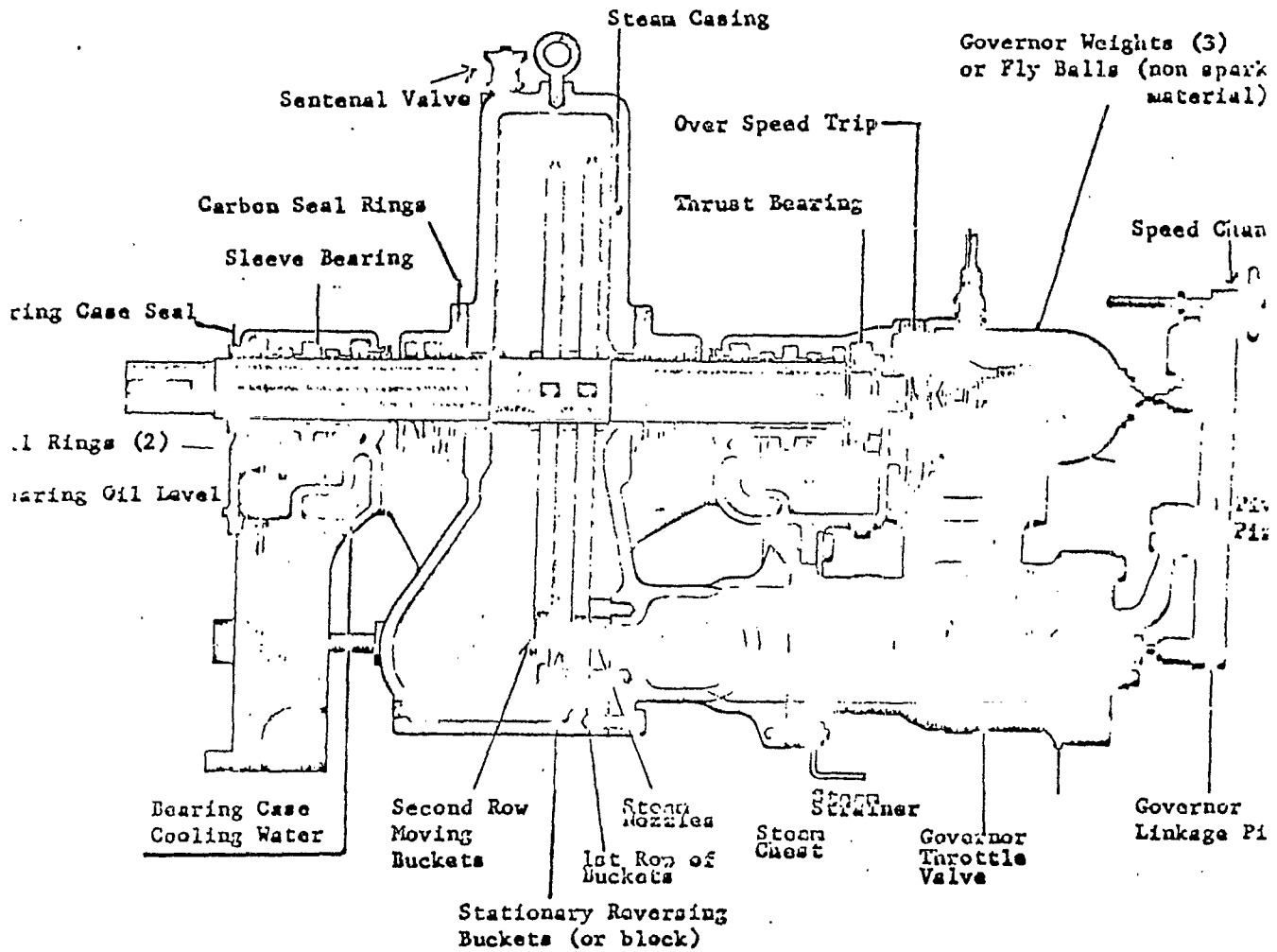
1. To connect shafts for the direct and consistent transmission of mechanical power from one shaft to the other.
2. To compensate for all types of misalignment between the shafts without inducing abnormal stresses and loads on the connected equipment and without tangible loss of power.
3. To allow for end or axial movement of the coupled shafts.



STEAM TURBINES

Steam enters the governor valve after passing through the strainer and throttle valve. The position of the governor valve determines how much steam is admitted to the steam chest and the nozzles. As the steam passes through the nozzles, its pressure drops and its velocity increases to a very high value. The rapidly moving steam then enters the first row of buckets, where part of its energy is used to drive the bucket wheel. The stationary reversing buckets serve to reverse the direction of flow so that the steam will be traveling in the proper direction to enter the second row of moving buckets. In the second row of moving buckets more energy is extracted from the steam. Finally, the steam leaves the turbine through the exhaust piping.

STEAM TURBINE



GOVERNOR - FLYBALL GOVERNOR & VALVE

James Watt devised a governor to control the speed of his steam engine. Very few changes or improvements have been made on it since then, and modern governors operate in much the same way. The engine rotated a shaft which caused two iron balls to move up as the speed of the machine increased. This movement caused the throttle to close and slow the engine down. When the engine went to slow the fly-balls fell, opening the throttle and increasing the speed of the machine.

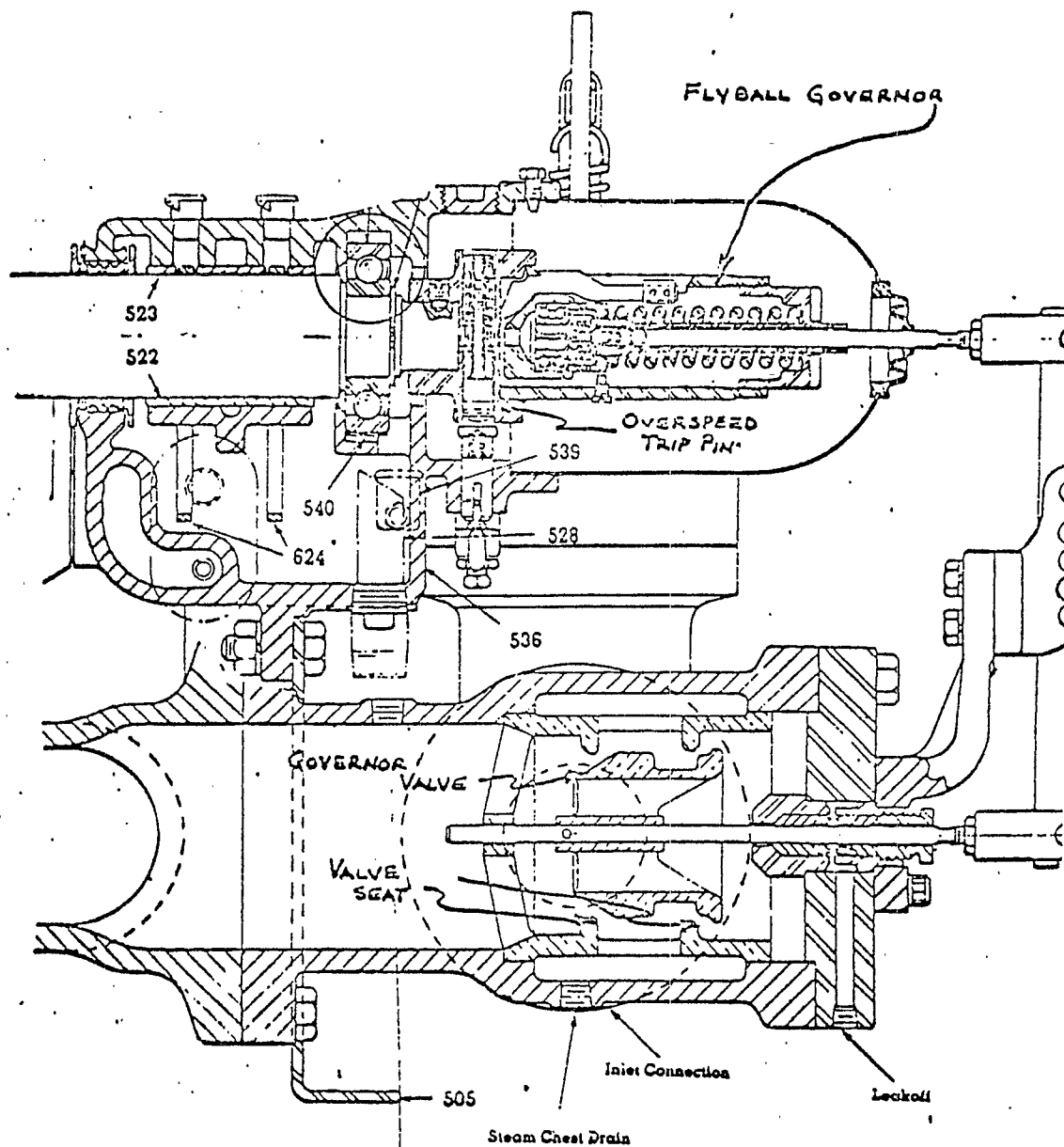


FIGURE 9 FLYBALL GOVERNOR AND VALVE

CHEV B8 6602

PP - 35, 36, 37, & 38

HOW THE DP GOVERNING SYSTEM WORKS

The DI governing system controls the speed and load of a turbine through the action of a hydraulic relayed, force restoring type governor.

The governing system consists of:

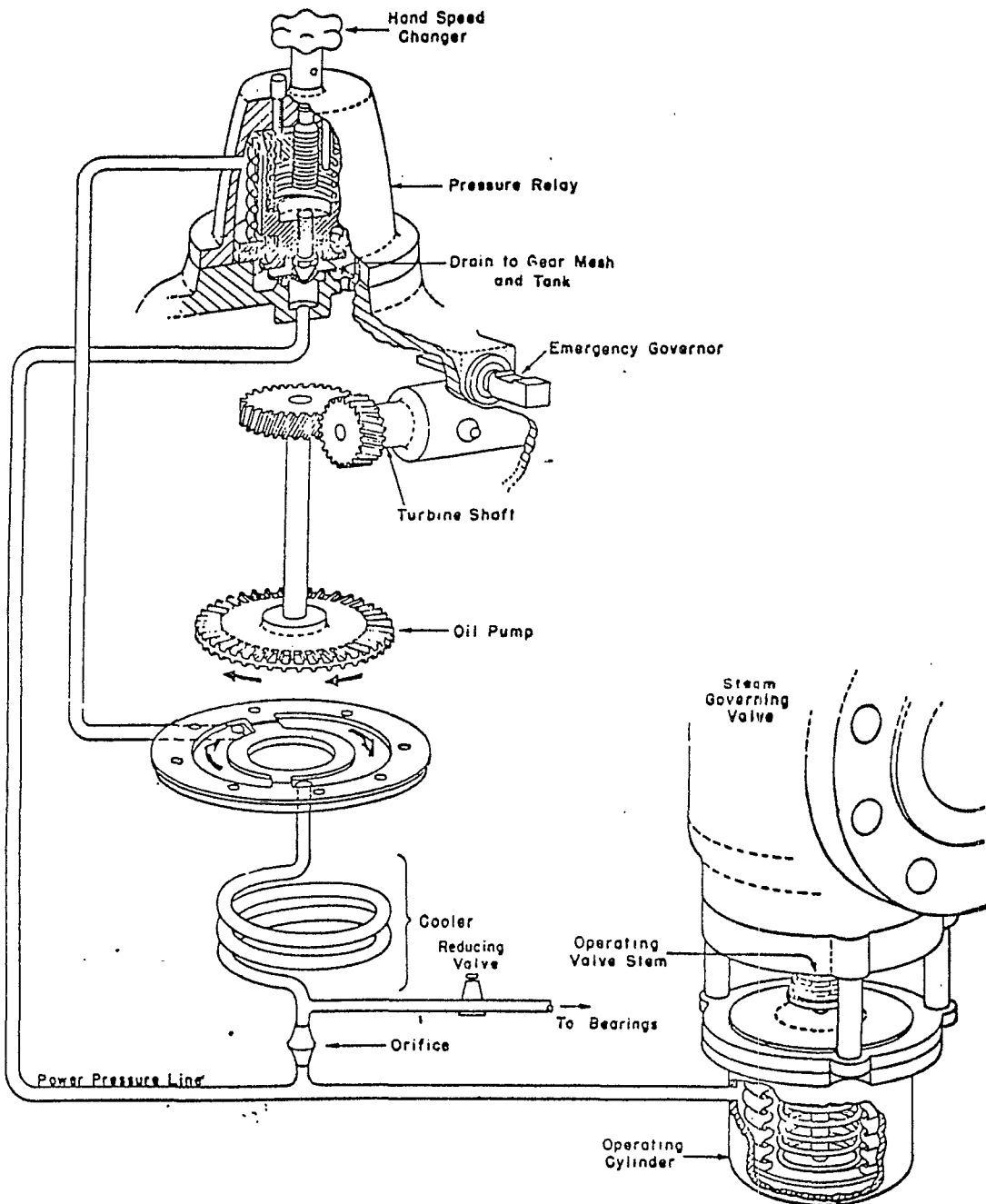
1. A pump which supplies a signal as a function of speed, a power source to operate the steam admission valve, and oil for bearing and gear lubrication.
2. An orifice relay which receives the speed function signal from the pump and through it modulates the power pressure.
3. An operating cylinder which receives the modulated power pressure from the relay and through it positions the steam admission valve.

The pump consists of an impeller and a casing which divides the pump into two separate sections. One section is used to supply the pressure signal which is a function of impeller speed. Since the pump is of a centrifugal type, viscosity changes due to temperature changes in the oil have little effect on the pressure head developed and the pressure signal will be constant for any given speed. The second section of the pump is used for the power source and the bearing lubrication.

The relay consists of a spring loaded diaphragm with a means of varying the spring tension for speed adjustment. This bellows operates a disc valve (or control valve). The speed function signal acts upon the spring loaded diaphragm to position the cup valve and bleed oil from the orificed power pressure line to establish a governed pressure in the operating cylinder.

The operating cylinder consists of a spring loaded bellows which receives the governed oil pressure from the relay and positions the steam admission valve.

SMALL TURBINE AND SUPERCHARGER DEPARTMENT
GENERAL ELECTRIC COMPANY, FITCHBURG, MASS.



SCHEMATIC DIAGRAM OF GOVERNING SYSTEM OF Q-E TYPE DP MECHANICAL-DRIVE TURBINE.

SCHEMATIC DIAGRAM

DIRECT ACTING WOODWARD PG GOVERNOR WITH PNEUMATIC SPEED CONTROL

PP - 4 A & B

(Increase in Air Pressure increases speed;
decrease in Air Pressure decreases speed)

When air pressure from the controller increases on diafram "A", it causes relay valve "E" to move downward allowing oil under pressure to enter the cylinder above piston "F". This forces "F" downward, causing flyball weights "W" to move inward, lowering relay valve "R" and letting high pressure oil enter buffer cylinder and push buffer piston "T" to the right. The downward motion of "F" also, through levers "G" and "D", returns "E" to its neutral position assuring a single position of "F" for each value of pressure on diafram "A".

Buffer piston "T" moving to the right forces oil into the cylinder above piston "H". The resulting downward motion of "H" opens governor valve "V" through action of lever "J".

At the same time, when buffer piston "T" moves to the right, a pressure drop is developed, causing a differential pressure to act on compensator piston "N", returning relay valve "R" to its neutral position. The adjustable orifice gradually allows the buffer piston to return to neutral establishing a definite turbine speed for each position of piston "F".

Similarly, a decrease in air pressure on diafram "A" results in a decrease in turbine speed.

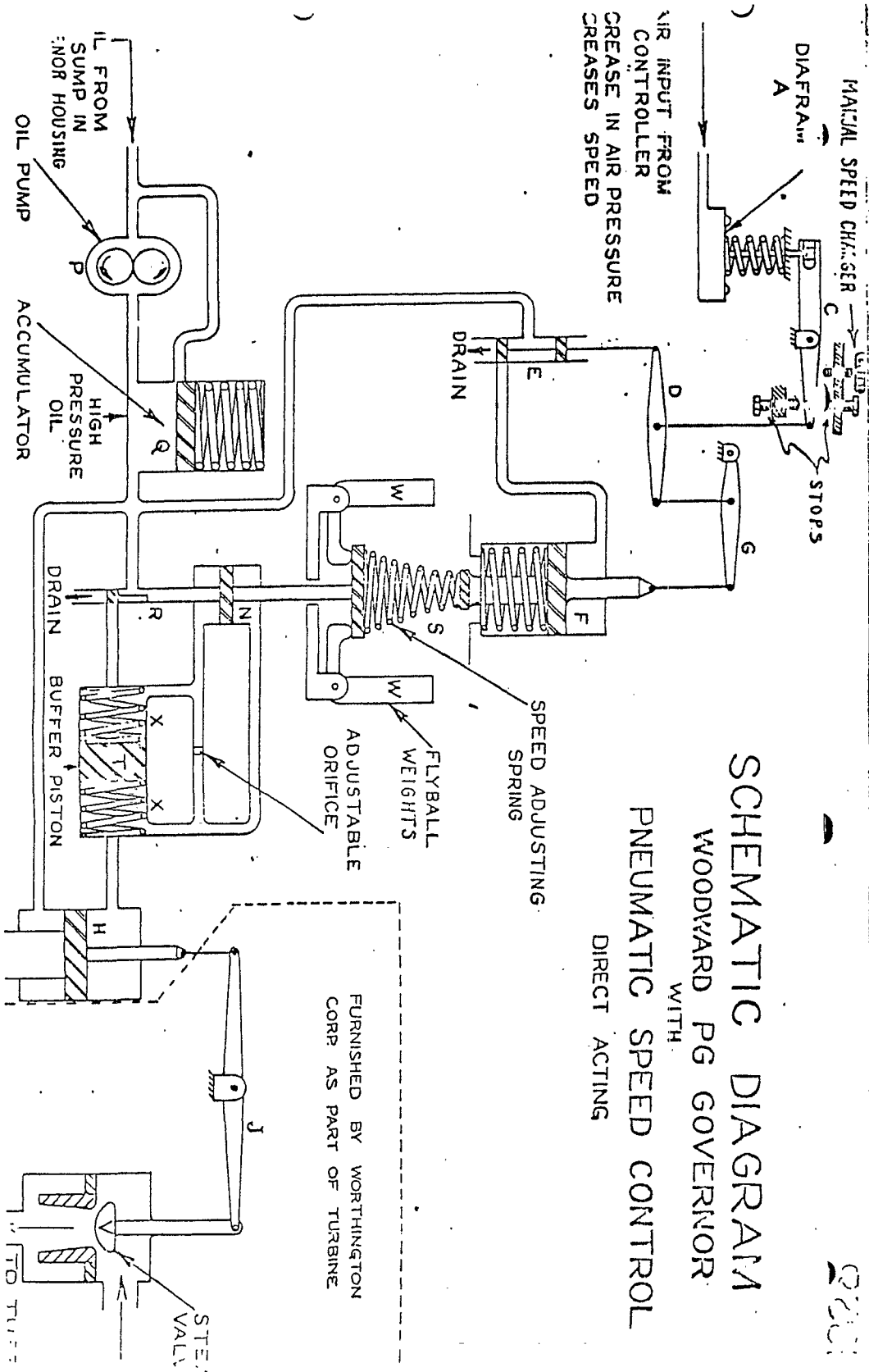
For each value of air pressure on Diafram "A", a definite turbine speed will be maintained, independent of turbine initial steam pressure or exhaust pressure variations.

The governor is also furnished with a manual speed changer to limit diafram "A" and actuate relay valve "E" manually to control the turbine speed within the same range as diafram "A".

Both maximum and minimum speed limits can be set by adjusting stops. In the event of total loss of air pressure from the controller, the turbine will not go below the minimum speed setting.

This governor falls within the limitations of NEMA Class D.

See also Woodward Governor Company Bulletins 36001, 36003 and 36008.



PG-PL GOVERNOR

SECTION I/GENERAL INFORMATION

INTRODUCTION

This bulletin provides description, operation, installation, adjustment, maintenance, and replacement parts information for the PG-PL governor.

The basic PG governor (pressure compensated governor) with a pneumatic speed setting mechanism (direct or reverse) and a short column that is used primarily for controlling engine or turbine speed has been assigned the designation PG-PL governor. This PG governor was first used on pipe lines, hence the PL, but has since found wide acceptance on all types of diesel engines, gas engines, steam turbines driving pumps and compressors, and many special applications. The PG-PL governor includes a pneumatic speed setting mechanism, standard short column, standard base assembly, and 12 foot-pound power cylinder assembly. The repair manual for the PG-A governor (similar to the PG-PL in speed setting, but with a long column to house various options for load control) is bulletin 36699.

All PG governors have the same basic components regardless of how simple or complex the complete control may be. The following components, found in each PG-PL governor, are sufficient to enable the governor to maintain a constant engine speed as long as the load does not exceed engine capacity:

1. an oil pump, storage area for oil under pressure, and a relief valve by which maximum oil pressure may be limited;
2. a centrifugal flyweight head-pilot valve assembly which controls flow of oil to and from the governor cylinder assembly;
3. a power cylinder assembly--sometimes referred to as a servomotor--which positions the fuel racks, fuel valve, or steam valve of the engine or turbine;
4. a compensating system for stability of the governed system;
5. a pneumatic speed setting mechanism for adjusting the governor speed setting.

▲ cutaway view of the PG-PL governor is shown in figure 1.

DESCRIPTION

The governor controls engine or turbine speed by controlling the amount of fuel or steam supplied to the engine or turbine. Speed control is isochronous, i.e., the governor will maintain constant engine or turbine steady state speed, within the capacity of the unit, regardless of load.

The standard operating oil pressure for PG governors is 100 psi. However, with appropriate modifications the oil pressure may be increased, thus increasing the work capacity of the power cylinder assembly. Table 1 lists typical governor oil pressures versus power cylinder work capacities.

Table 1. Governor Oil Pressure Versus Power Cylinder Work Capacities (Typical)

Governor Operating Oil Pressure (PSI)	Power Cyl. Work Capacities in Ft-Lb		
	12	17	29
100 (std.)	12	17	29
130		22	38
200		34	58

An air pressure signal from a pneumatic air transmitter or controller supplies air to the governor speed setting mechanism. The governor will control the engine at a definite speed for each air pressure. The most common air pressure range for the governor is from 3-15 psi. Normal minimum control air pressure is 3 psi; however, a minimum of 1 psi and a maximum of 100 psi can be accommodated. The governor speed range normally falls between 250-1000 rpm, but a low speed of 200 rpm or a high speed of 1600 rpm can be obtained. Contact Woodward Governor Company for recommended control air pressure to governor speed setting relationship to meet the requirements of the particular installation.

The pneumatic speed setting mechanism (direct or reverse) is a bellows type mechanism and is standard equipment on all PG-PL governors now manufactured by Woodward. The speed setting unit is an accurate durable mechanism which

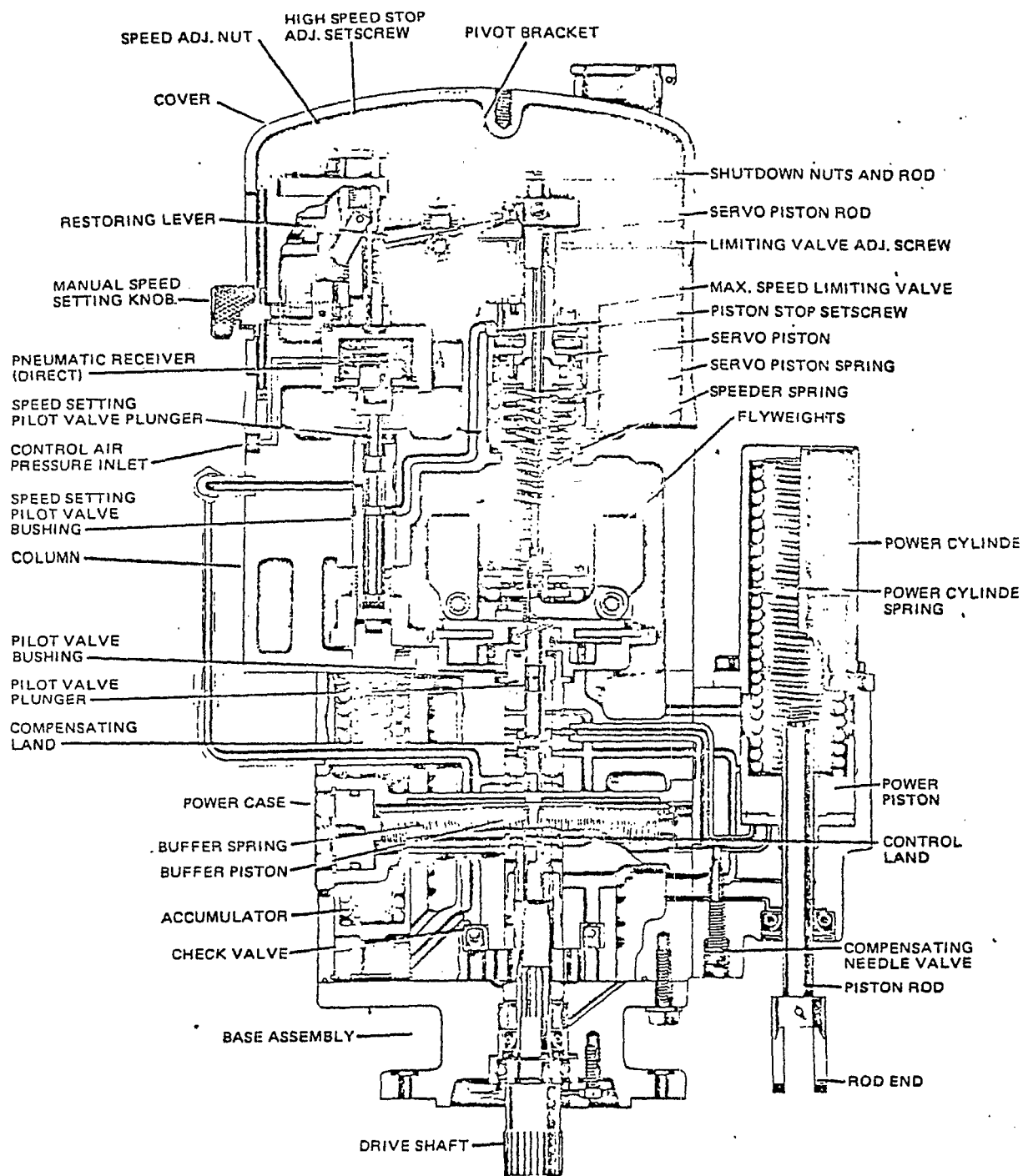


Figure 1. Cutaway View PG-PL Governor

virtually eliminates the hysteresis loops encountered with less sensitive pneumatic speed setting elements. (A hysteresis loop is a plot of the speeds obtained at various control signal pressures; one portion is recorded as speed setting signals are being increased, the other portion as the signals are being decreased.) Bellows type speed setting provides a definite, accurate relationship between speed and speed signal.

The speed setting mechanism is available for use with air input signals of varying range and magnitude (e.g. 3 to 15 psi, 20 to 70 psi, etc.). Depending upon the exact configuration installed in the governor, speeds may be adjusted up to a 5 to 1 range. The speed setting mechanism can be furnished to increase governor speed setting for an increase in control air pressure (direct type) or to increase

governor speed setting for a decrease in control air pressure (reverse type).

The manual speed setting knob permits manual operation when the air pressure signal is not available.

Diaphragm receiver models of the governors are obsolete and no longer manufactured as a complete unit. However, replacement parts for these units are available and detail information on the units is found at the end of this manual.

As is the case with any governor of any type, it is essential that the engine or turbine be equipped with a separate overspeed shutdown device to prevent runaway in the event of failure of the governor, the mechanism which drives it, or the control it operates.

SECTION III/PRINCIPLES OF OPERATION

INTRODUCTION

The sectional view of the PG-PL governor (see figure 1) serves to indicate the relative position of the various governor components in the complete assembly. The connecting oil passages between parts are not necessarily in their correct location, but are simplified to facilitate their location. The lower part of the governor consists of the base and power case and the basic components of the hydraulic PG isochronous governor, which functions to maintain a constant engine speed by controlling the fuel supplied to the engine. The upper part of the governor consists of the column, cover, and related parts; it also consists of the pneumatic speed setting mechanism, and optional shutdown and protective devices where applicable.

DESCRIPTION OF OPERATION

The schematic diagram (figure 2) illustrates the essential parts of the governor and speed setting mechanism which are required to regulate fuel and control engine speed.

Speed adjusting in the governor is effected by controlling the position of the speed setting servo piston. Movement of the servo piston to a higher or lower speed setting is obtained by admitting or draining pressure oil to or from the area above the servo piston.

The flow of governor oil to or from the area above the servo piston is controlled by the speed setting pilot valve plunger - contained in a rotating bushing - which is actuated by a controlled air pressure signal or by a manual control knob.

After each speed setting change, a restoring lever connected between the servo piston rod and speed setting pilot valve plunger returns the plunger to the closed port position, stopping the flow of oil to or from the area above the servo piston, thus holding the piston at the position for the particular speed setting of the governor.

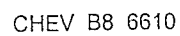
The governor drive shaft passes through the governor base into the pump drive gear, which is direct connected to the rotating pilot valve bushing. The flyweight head is secured to the upper end of the pilot valve bushing, thus providing a direct drive from the engine to the flyweights. At any speed setting of the governor, when the engine is on speed, the centrifugal force of the flyweights will balance the opposing force of the speeder spring with the flyweights in the vertical position, and the control land of the pilot valve plunger will be covering the regulating ports in the rotating pilot valve bushing.

Pressure seal grooves are supplied with pressure oil through the regulating port to prevent the oil trapped between the power piston and the buffer piston from leaking past the power piston, power piston rod and pilot valve stem. To make up leakage of the seal oil and hold the power piston in a steady state position against the power spring - when the engine is on speed with a steady load -- the pilot valve plunger will be below center enough to supply the required amount of oil through the regulating port.

The governor oil pump supplies pressure oil to the rotating pilot valve bushing, speed setting pilot valve bushing, pressure seal grooves, and to the accumulators, with excess oil (at maximum pressure) bypassing from the accumulators to the governor sump. Duplicate suction and discharge ball check valves at the pump permit rotation of the governor in either direction.

The pilot valve plunger moves up and down in the rotating pilot valve bushing to control the flow of oil to or from the power cylinder assembly. When the pilot valve plunger is centered (i.e., the control land of the plunger exactly covers the control port of the bushing), no oil flows to or from the power cylinder assembly.

The greater of two forces moves the pilot valve plunger up or down. The centrifugal force developed by the rotating flyweights is translated into an upward force which tends to



lift the plunger. The centrifugal force is opposed by the downward force of the speeder spring. When the opposing forces are equal, the pilot valve plunger is stationary.

With the pilot valve plunger centered and the engine running on-speed, a change in either of the two forces will move the plunger from its centered position. The plunger will be lowered (1) if the governor speed setting is unchanged but an additional load slows the engine and governor (thereby decreasing the centrifugal force developed by rotating flyweights), or (2) if the engine speed is unchanged but the speeder spring force is increased to raise the governor speed setting. Similarly, the pilot valve plunger will be raised (1) if the governor speed setting is unchanged but load is removed from the engine causing an increase in engine and governor speed (and hence, an increase in the centrifugal force developed by the rotating flyweights), or (2) if the engine speed is unchanged but the speeder spring force is reduced to lower the governor speed setting.

The thrust bearing atop the ballarm toes permits the pilot valve bushing to rotate while the pilot valve plunger does not rotate. In this way, static friction between the bushing and plunger is minimized.

There are several styles of flyweight head assemblies available. The exact model used in any one governor depends upon the application.

A "solid" head assembly is used in governors on prime movers which afford a smooth drive to the governor.

"Spring driven" and "spring driven, oil damped" head assemblies are used to filter torsional vibrations which may be imparted to the governor by the drive from the engine. (These torsional vibrations may originate from a source other than the drive itself but reach the governor through the drive connection). Unless minimized or eliminated, the flyweight head will sense these torsional vibrations as speed changes and continually adjust the fuel valve or racks in an attempt to maintain a constant speed.

Movements of the power piston are transmitted by the piston rod to the engine fuel linkage. Regulated oil pressure under the power piston is used to raise the power piston - to increase fuel - and the power spring above the power piston is used to lower the power piston to decrease fuel.

Located between the pilot valve bushing and the power piston is the buffer compensating system, consisting of the buffer cylinder and piston, the buffer springs, and the compensating needle valve. Lowering the pilot valve plunger

permits a flow of pressure oil from the pilot valve bushing into the buffer system and power cylinder to raise the power piston and increase fuel. Raising the pilot valve results in a flow of oil from the power cylinder and buffer system to the governor sump, and the power spring moves the power piston down to decrease fuel to the engine.

This flow of oil in the buffer system - in either direction - carries the buffer piston in the direction of flow, compressing one of the buffer springs and releasing the other. This action creates a slight differential in the pressures of the oil on opposite sides of the buffer piston, with the higher pressure on the side opposite the spring which is compressed. These differential oil pressures are transmitted to the areas above and below the compensating land on the pilot valve plunger, producing an upward or downward force on the compensating land which assists in re-centering the pilot valve plunger whenever a fuel correction is made.

The vertical position of the flyweights with the control land of the pilot valve covering the regulating port indicates that the engine is on-speed.

THEORY OF OPERATION

See figure 2 for the schematic diagram of the essential components of the basic governor and speed setting mechanism and the relative positions they assume when the engine is operating on-speed under steady-state conditions. Differences may exist in the actual design details of these components from one governor to another, but the scheme of operation is the same in each.

The schematic arrangement of the "direct" speed setting mechanism (governor speed increases as the control air pressure signal increases) is incorporated into the diagram of figure 2. The inset shown on figure 2 shows the "reverse" speed setting (governor speed decreases as the control air pressure signal increases) version.

The following theory of operation describes the direct speed setting mechanism. The sequence of events occurring in the governor take place more or less in a simultaneous manner, rather than step by step as described in the following paragraphs.

SPEED INCREASE

An increase in the control air pressure signal to the pneumatic receiver assembly is sensed by a bellows. Through a mechanical connection to the speed setting pilot valve plunger, the bellows movement - caused by changes

in the input signal pressure -- displaces the speed setting pilot valve plunger to change the governor speed setting. The increased pressure compresses the bellows to lower the speed setting pilot valve plunger. Pressure oil flows to the area above the speed setting servo piston to force the piston down, and thus increase the governor speed setting.

As the servo piston moves down, a restoring lever -- connected between the servo piston rod and speed setting pilot valve plunger on a ball bearing pivot -- increases the lifting force on a restoring spring attached to the restoring lever. When the lifting force of the restoring spring is equal to the downward force resulting from the increased pressure signal, the speed setting pilot valve plunger will be returned to its centered position.

Increasing the speed setting of the governor increases the downward pressure of the speeder spring on the toes of the flyweights and the flyweights move in, lowering the pilot valve plunger and opening the control port.

Opening the port in this direction admits pressure oil into the buffer system, causing the buffer piston to move to the right and transfer an equal volume of oil to the power cylinder, forcing the power piston up in the direction to increase fuel.

As the buffer piston moves in the direction of the oil flow -- from pilot valve to power cylinder -- the right buffer spring is compressed and the left spring is relieved. This produces an intermediate oil pressure on the left side of the buffer piston which is higher than the pressure of the trapped oil on the right side of the buffer piston and spring displacement.

Simultaneously with the movement of the power piston and buffer piston, the differential oil pressures on opposite sides of the buffer piston are transmitted to the upper and lower sides of the compensating land, with the higher pressure on the lower side causing an upward force on the compensating land which will increase until (added to the upward force of the flyweights) it will balance the speeder spring force, raise the pilot valve plunger enough to cover the control port, and return the flyweights to the vertical position. As soon as the control port is covered the power piston will be stopped at a new position corresponding to the increased amount of fuel needed to operate the engine at the desired higher speed. The engine is still accelerating toward the new speed setting.

As the centrifugal force of the flyweights increases to a higher value with engine acceleration, the upward oil force

at the compensating land is reduced to zero by the equalization of the oil pressures in the buffer system through the compensating needle valve. If the needle valve is correctly adjusted the oil pressures will equalize at the same rate as the increase in the centrifugal force of the flyweights, and the flyweights will remain in the vertical position, keeping the control port covered by the control land of the pilot valve, and holding the power piston stationary at the new position. Equalizing the oil pressures in the buffer system allows the buffer springs to return the buffer piston to center in the buffer cylinder.

The engine will now be running at a higher speed with an increased fuel setting.

SPEED DECREASE

A decrease in the control air pressure signal to the bellows of pneumatic receiver assembly allows the restoring spring -- attached to restoring lever -- to lift the speed setting pilot valve plunger. Oil drains from the area above the servo piston, the servo piston spring forces the piston to rise and thus decrease the speeder spring compression and lower the governor speed setting.

The restoring lever follows the movement of the servo piston, moves up and, in so doing, decreases the lifting force on the restoring spring. When the servo piston and right end of the restoring lever has moved up sufficiently to balance the upward force of the restoring spring to equal the decrease in downward force resulting from the decrease in control air pressure signal, the speed setting pilot valve plunger will have returned to its centered position.

Lowering the speed setting of the governor decreases the downward pressure of the speeder spring on the toes of the flyweights and the flyweights move out, raising the pilot valve plunger and opening the control port.

Opening the port in this direction permits oil to flow from the buffer system to the governor sump. This will lower the oil pressure in the buffer system and the power spring will force the power piston down in the direction to decrease fuel. As the buffer piston moves in the direction of the oil flow -- from power cylinder to pilot valve -- the left buffer spring is compressed and the right spring is relieved. This produces a pressure in the trapped oil, on the right side of the buffer piston which is higher than the intermediate oil pressure on the left side of the buffer piston, by an amount proportional to the displacement of the buffer piston and spring.

Simultaneously with the power piston and buffer piston

ment, these pressures will be transmitted to the compensating land, with the higher pressure now on the upper side of the land, causing a downward force which will increase until (added to the downward force of the speeder spring) it will balance the flyweight force, lower the pilot valve plunger enough to cover the control port, and return the flyweights to the vertical position. As the control port is covered the power piston will stop at a new position to correspond to the reduced amount of fuel required to operate the engine at the desired lower speed. The engine will be still decelerating toward the new speed setting.

As the centrifugal force of the flyweights decreases with engine deceleration, the downward oil force at the compensating land will again be reduced to zero by the equalization of the oil pressures in the buffer system through the compensating needle valve. With the needle valve correctly adjusted the oil pressures will equalize at the same rate as the decrease of centrifugal force in the flyweights, and the flyweights will remain in the vertical position, keeping the control port covered by the control end of the pilot valve, and holding the power piston stationary at the new position. Again, the buffer piston will be returned to center by the action of the buffer springs. The engine will now be running at a lower speed with a reduced fuel setting.

Bypass ports are provided in the buffer cylinder to facilitate large corrective movements of the power piston.

A large increase or decrease in the speed setting of the governor, or a large increase or decrease of load on the engine, will require a correspondingly large movement of the power piston to make the necessary correction to the fuel setting. Under such conditions, the buffer piston will move only far enough to the left or right to effect an opening at the bypass port (pressure or drain). Oil will then flow directly to or from the power cylinder through the bypass port without further increasing the differential oil pressure force existing on the compensating land.

As soon as sufficient governor movement and fuel correction has occurred to effect a correction of engine speed toward the speed at which the governor is set, the differential oil pressures -- still present -- will act on the compensating land to re-center the pilot valve plunger, as described in the previous paragraphs.

With a large decrease in load the power piston assembly moves to the "no fuel" position, closing the compensating passage from the power cylinder to the compensating needle valve and blocking passage of oil from the right end of the left end of the buffer cylinder, so that the needle valve cannot equalize buffer oil pressures in the usual

manner. The buffer piston will have moved off center to the left and will be held there by the oil now trapped between the power piston and the buffer piston.

The higher pressure of the oil on the right side of the buffer piston -- produced by the compression of the left buffer spring -- will act on the receiving compensating land to add to the effect of the speeder spring setting and provide a temporary higher speed setting of the governor.

As the engine decelerates to a speed slightly below this higher speed setting, the governor will respond to raise the power piston (and restore fuel supply) in the normal manner, uncovering the port to permit passage of oil through the compensating needle valve so that the governor and engine will stabilize at the speed corresponding to the actual speed setting of the governor. This minimizes possible under-speeding of the engine when a large load decrease occurs.

MANUAL SPEED SETTING

The manual speed setting mechanism can be used to adjust the speed setting of the governor to any point within the normal speed range when the control air pressure signal is not available.

With no air signal, the restoring spring holds the pneumatic low speed stop screw in contact with the restoring lever. The speed setting pilot valve plunger is thus mechanically connected to the movement of the restoring lever. The grounded loading spring which keeps the restoring lever against the ball bearing pivot continually urges the bearing and speed setting screw in the downward direction. Turning the manual speed adjusting knob clockwise (to increase the governor speed setting) lowers the stop collar under the base speed adjusting nut. The speed setting screw with the ball bearing pivot will move down with the stop collar until the high speed stop adjusting setscrew hits the high speed stop pin; further clockwise turning of the manual knob will have no effect on the speed screw position.

As the speed setting screw and the ball bearing pivot are lowered, the left end of the restoring lever pushes the pneumatic low speed adjusting screw down and, in so doing, lowers the speed setting pilot valve plunger. Oil flows to the speed setting cylinder to push the speed setting piston down and raise the governor speed setting. The downward movement of the piston raises the left end of the restoring lever to "lift" the pilot valve plunger back to center.

Turning the manual speed adjusting knob counterclockwise will raise the speed setting screw and ball bearing pivot, raise the left end of the restoring lever, and thereby lift the speed setting pilot valve plunger. As the piston moves up to decrease the governor speed setting, the restoring lever movement recenters the pilot valve plunger.

TEMPERATURE COMPENSATION

Temperature compensation on older governors is incorporated in the speed setting mechanism through a bimetal strip in the restoring lever. The temperature compensation in later governors is in the speeder spring and there is no bimetal strip.

LOSS OF PNEUMATIC SIGNAL

"DIRECT" TYPE BELLOWS. The pneumatic low adjusting screw is adjusted to contact the restoring lever when the control air signal and governor speed are at their normal

minimum. Thus, should the air signal be interrupted -- either accidentally or intentionally -- or be reduced below the pressure required for minimum speed, the restoring spring will lift the speed setting pilot valve plunger until the adjusting screw contacts the restoring lever. With the pilot valve plunger raised, the speed setting piston will move up to low speed position. At this position, the restoring lever turning about the ball bearing pivot and pushing down on the adjusting screw, will have recentred the pilot valve plunger. The governor will, therefore, go to minimum speed setting if the air signal is lost.

"REVERSE" TYPE BELLOWS. The pneumatic low speed adjusting screw is adjusted to just clear the restoring lever when the control air signal is at its normal maximum setting. Thus, should the air signal be interrupted -- either accidentally or intentionally -- the spring under the bellow will act to lower the speed setting pilot valve plunger and allow the governor to go to maximum speed setting.

UTILITIES 7

UTILITIES

PU-1342

ELECTRICAL

Main Power to Unit:

<u>Voltage</u>	<u>Source</u>
2300 (Circuit 55B) except C-500's	No. 90 Auto Switch Station
2300 (Circuit 85B) - C-500's	207 Substation
440	184 Substation
110 (Normal)	184 Substation
110 (Emergency - Lights and Instruments and C-500's gear oil pumps)	43 Substation

STEAM

- a. 650 PSIG - used on turbine drives on C-400 A and B Hydrogen Recycle Gas Compressors which exhaust to surface condensers E-405A and E-405B, respectively, and P-8A Platformer Reactor Charge Pump, P-3 H.B. Reactor Charge Pump and P-8B Platformer Rx - H.B. Rx Charge Common Spare Pump which exhaust to E-607 surface condenser.
- b. 125 PSIG - used on all other turbine driven and reciprocating pumps and C-401 Gulfiner Hydrogen Compressor. It is also used on all vacuum jets, as steam out to the towers and heater fireboxes, as utility steam and as snuffing and safety steam. 125 lb. steam is also connected to the discharge of the Hydrobon charge pump (P-3) and all reboiler pumps (P-2, P-7, P-600 and P-601) in case of emergency.

The 125 psig steam drivers exhaust either into the 15 psig system or E-607 Surface Condenser as follows:

15 psig Exhaust Steam

P-1B	Prefractionator Reflux Pump (Spare)
P-4	Water Injection Pump
P-6B	H.B. Stripper Reflux Pump (Spare)
P-10B	Prefractionator O.H. Pump (Spare)
P-400B	Prefractionator Charge - H.B. Stripper Charge Common Spare
P-402B	E-405A Surface Condenser Condensate Pump (Spare)
P-402D	E-405B Surface Condenser Condensate Pump (Spare)
P-603B	Depropanizer Ref.-Deb. Ref. Common Spare
P-606B	E-607 Surface Condenser Condensate Pump (Spare)
P-609B	Deb. Bottoms Pump (Spare)
P-501	Drips from V-504 Pump
C-401	Gulfiner H ₂ Compressor

E-607 Surface Condenser

P-2A	Pref. Bottoms Pump
P-2B	Pref. Bottoms - H.B. Stripper Reboiler Common Spare
P-5	H.B. Stripper Charge Pump
P-7	H.B. Stripper Reboiler Pump
P-401A	Deprop. Charge Pump
P-401B	Deprop. Charge Pump (Spare)
P-600A	Deprop. Reboiler Pump
P-600B	Deprop. Reboiler Pump (Spare)
P-601	Debut. Reboiler Pump
P-602B	Debut. Reboiler Pump (Spare)
P-604	Debut. Oil Pump

CHEV B8 6616

UTILITIES PU 1342 - Continued

- c. Condensate from Surface Condensers is sent to 15 Boiler House. Condensate is also used to water wash Pref. O.H. Condensers, H.B. Effluent Condensers, and the Hydrogen Filter. It also is used for water injection.

COOLING WATER

The cooling water is supplied to the unit by 169 Cooling Tower, located west of the unit at the end of 28th Street. Other units supplied by 169 are IU 341, DCU 841-2, PU 1343 and No. 3 Gas Plant. The cooling water is supplied at 88-95°F and 40 psig normally.

FILTER WATER

Filter water supplied to the unit is used for the toilet facilities.

SALT WATER

Low pressure (20-25 psig) salt water is used for unit wash-up water and high pressure (70-80 psig), salt water is connected to the fire hydrants around the unit.

AIR

Yard air is supplied to the unit from the west battery limit, and supplies both the utility and instrument air systems on the unit. The normal operating pressure is about 90-100 psig and the instrument air branch maintains about 50 psig. In case of an air failure or reduction in instrument air pressure to 35 psig, the air compressors C-1A; C-1B and C-1C supply the instrument air needs automatically.

RWL:mkw:10-28-74

EQUIPMENT 7

PLATFORMING UNIT NO. 1342

Equipment List

Hydrobon Section

V-1	Prefractionator Column	V-409	Prefractionator Charge Fil
V-2	Prefractionator Receiver	V-410	Prefractionator Charge Fil
V-3	Hydrobon Reactor	V-411	Prefractionator Charge Fil
V-4	Hydrobon Products Separator		
V-5	Hydrobon Flash Drum		
V-6	Hydrobon Stripper Column		
V-7	Hydrobon Stripper Receiver		
V-8	Corrosion Inhibitor Tank		
V-9	Corrosion Inhibitor Tank		
V-10	Corrosion Inhibitor Tank		

E-1	Prefractionator Condensers (4)
E-2	Prefractionator Overhead Coolers (2)
E-3	Prefractionator Bottoms Coolers (2)
E-4	Gas Exchanger (Hydrobon)
E-5	Charge Exchangers (4)
E-6	Stripper Feed Exchangers (2)
E-7	Hydrobon Products Condensers (2)
E-8	Hydrobon Stripper Condensers (2)

P-1A	Prefractionator Reflux Pump
P-1B	Prefractionator Reflux Pump (Spare)
P-2A	Prefractionator Bottoms Pump
P-2B	Common Spare for Pumps P-2A and P-7
P-3	Hydrobon Reactor Charge Pump
P-4	Water Injection Pump
P-5	Hydrobon Stripper Charge Pump
P-6A	Hydrobon Stripper Reflux Pump
P-6B	Hydrobon Stripper Reflux Pump (Spare)
P-7	Hydrobon Stripper Reboiler Pump
P-8A	Platforming Reactor Charge Pump
P-8B	Common Spare for Pumps P-3 and P-8A
P-9	Corrosion Inhibitor Injection Pump
P-10A	Prefractionator Net Overhead Pump
P-10B	Prefractionator Net Overhead Pump (Spare)

H-602	Prefractionator Reboiler Heater
H-1	Hydrobon Charge Preheater
H-2	Hydrobon Charge Heater
H-3	Hydrobon Stripper Reboiler Heater

Reactor Section

V-400	No. 1 Reactor
V-401	No. 2 Reactor
V-402	No. 3 Reactor
V-404	Reactor Products Separator
V-405A	Chem. or Condensate Injec. Tank
V-405B	Chem. or Condensate Injec. Tank
V-406	Fuel Gas Drum
V-407	Product Gas Drum
V-408	Compressor Suction (C-401)

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Reactor Section (Continued)

E-400A Prefractionator Charge Exchanger
E-400B Prefractionator Charge Exchanger
E-401A Recycle Gas Exchanger
E-401B Recycle Gas Exchanger
E-402A Combined Feed Exchangers (8)
E-402B Combined Feed Exchangers (8)
E-403A Reactor Products Condensers (4)
E-403B Reactor Products Condensers (4)
E-405A Surface Condenser for C-400A
E-405B Surface Condenser for C-400B

P-400A Prefractionator Charge Pump
P-400B Common Spare for Pumps P-400A & P-5
P-401A Depropanizer Charge Pump
P-401B Depropanizer Charge Pump (Spare)
P-402A Surface Cond. Condensate Pump for E-405A
P-402B Sur. Cond. Condensate Pump (Spare)
P-402C Surface Cond. Condensate Pump for E-405B
P-402D Sur. Cond. Condensate Pump (Spare)
P-404 Chem. or Condensate Injec. Pump

H-400 Flatforming Charge Heater
H-401 Flatforming Intermediate Heater

C-400A Recycle Gas Compressor
C-400B Recycle Gas Compressor
C-401 Gulfiner Gas Compressor

Fractionation Section

V-600 Depropanizer Column
V-601 Depropanizer Receiver
V-602 Debutanizer Column
V-603 Debutanizer Receiver
V-604 Depentanizer Column-Out of Service
V-605 Depentanizer Receiver-Out of Service

E-600 Depropanizer Feed Exchangers (2)
E-601 Depropanizer Condensers (3)
E-602 Debutanizer Condensers (2)
E-603 Debutanizer Overhead Cooler
E-604 Depentanizer Condenser (2)-Out of Service
E-605 Depentanizer Overhead Coolers (2)-Out of Service
E-606 Debutanizer Bottoms Cooler
E-607 Surface Condenser

P-600A Depropanizer Reboiler Pump
P-600B Depropanizer Reboiler Pump (Spare)
P-601 Debutanizer Reboiler Pump
P-602A Depentanizer Reboiler Pump-Out of Service
P-602B Common Spare for Pumps P-601 & P-602A
P-603A Depropanizer Reflux Pump
P-603B Common Spare for Pumps P-603A and P-604
P-604 Debutanizer Overhead Pump
P-605A Depentanizer Overhead Pump-Out of Service

Fractionation Section (Continued)

P-605B Common Spare for Pumps P-605A and P-608
P-606A Surface Condenser Condensate Pump for E-607
P-606B Surface Condenser Condensate Pump (Spare)

P-608 Depentanizer Net (Rerun) Overhead Product Pump-Out of Service
P-609A Debutanizer-Depentanizer Net Bottoms Pump
P-609B Debutanizer-Depentanizer Net Bottoms Pump (Spare)

H-600 Depropanizer Reboiler Heater
H-601 Debutanizer Reboiler Heater

Hydrogen Gathering System

V-500 Hydrogen Filter
V-501 Compressor Suction Drum (C-500's)
V-503 Compressor Discharge Drum (C-500's)
V-504 Hydrocarbon Drips Drum

E-500 Compressor Discharge Cooler

P-501 Hydrocarbon Drips Pump

C-500A Hydrogen Booster Compressor
C-500B Hydrogen Booster Compressor
C-500C Hydrogen Booster Compressor

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The following procedures outline general steps to be taken in some types of foreseeable emergency situations. Since it is impossible to anticipate all such situations, these instructions are general only and each emergency must be handled according to the existing conditions.

It is absolutely essential that all operating personnel, and especially all No. 1 Operators, be thoroughly familiar with the unit so that proper corrective measures can be taken without delay.

A. POWER FAILURE

1. The steam driven spares for all motor driven pumps must be put on as quickly as possible. Handle them in the following order of importance:

- a. Lube and Seal Oil Pumps for Recycle Comp.:

Stm. spare for Elec. Lube or Seal Oil for Comp.

PCL - 2	PCL - 1	Lube	C-400A
PCS - 2	PCS - 1	Seal	C-400A
PCL - 4	PCL - 3	Lube	C-400B
PCS - 4	PCS - 3	Seal	C-400B

- b. All reflux pumps and Prefract. Charge Pump:

Stm. spare for Elec.:

P-6B	P-6A	Hydrobon Stripper Reflux
P-1B	P-1A	Prefract. Reflux
P-400B	P-400A	Prefract. Charge
P-603B	P-603A	Deprop. Reflux

- c. All steam condensate pumps from surface condensers:

Stm. spare for Elec. Cond from surface condenser

P-606B	P-606A	Pump
P-402B	P-402A	C-400A
P-402D	P-402C	C-400B

- d. Pumps on products to field:

Stm. spare for Elec.:

P-609B	P-609A	Debut. Flat. to field
P-10B	P-10A	Prefract. OH to field

2. The electric driven Hydrogen Booster Compressors will stop with loss of power. Immediately switch the hydrogen to the Product Gas Drum and use the "hot line" telephone to inform the Hydrogen Maker Unit. Block in each comp.

A. POWER FAILURE (Continued)

3. Put all firing gas controllers on manual control, since the electronic temperature controllers will be out of service.

For this reason, all manual air controllers should be kept adjusted so that the air output will match the normal air output of the controller, then these instruments can be put on manual by merely flipping the transfer switch from "automatic" to "manual".

4. A complete power failure will kick off all the cooling tower fans. As soon as power is restored, the personnel in charge of the fans must reset the starting switch circuits immediately.
5. If the power is not restored within a short time, the loss of cooling tower fans will cause the water to become so hot that the unit must be shut down.

B. INSTRUMENT AIR FAILURE

1. Locate reason for failure. It could be due to several causes, including the following:
 - a. Failure in yard air distribution system outside the battery limits. Use air-jammers to supply instrument air to unit.
 - b. Failure of pressure reducing valves on instrument air system inside battery limits. Admit enough air thru the bypass valve to keep instruments on control.
 - c. Stoppage in air driers, lines, or filters. Bypass that section responsible.
2. If the air failure is complete, it will require an immediate shutdown since all regulators are air operated and all flows are measured by means of D/P cells which require air. The following steps should be taken:
 - a. Cut out all fires and put steam in fire box.
 - b. Shut down and block off Reactor Charge Pumps. Leave recycle compressors operating.

B. INSTRUMENT AIR FAILURE (Continued)

2. c. Shut down unit in orderly fashion. Open bypass valves where necessary to permit flow thru lines.
- d. Block in Platformer Reactor System and Towers and leave bottled-up.
- e. Shut down Booster Comp. and switch Hydrogen to Product Gas Drum.
3. Always keep in mind that all pressure indicators in the control room are pneumatically transmitted and in the event of air failure, these are useless.

C. COOLING WATER FAILURE

1. A complete loss of cooling water would require an immediate shutdown of the entire unit.
 - a. Cut out all fires and put steam in fire boxes.
 - b. Shut down and block off Reactor Charge pumps.
 - c. Shut down unit in orderly fashion.
 - d. Keep recycle compressors running as long as possible. Without cooling water, lube and seal oil will soon get hot.
 - e. Keep reboiler pumps running until steam is in the fire boxes or as long as possible.
 - f. Block in Platformer Reactor System and Towers and leave bottled-up.
 - g. Shut down Hydrogen Booster Comp. and switch H₂ to Product Gas Drum.
 - h. Use Product Gas Drum or flare lines to reduce pressures on all vessels below pop-off pressures.

D. STEAM FAILURE

1. A partial steam failure or steam "shortage" will require all plant units to reduce steam usage depending on the severity, and the Shiftforeman will initiate the step-wise procedure:

D. STEAM FAILURE (Continued)

1. a. For PU 1342, this will usually require shutting down one compressor.
 - b. Lower heater outlet temperatures 15 to 20°F on all reactor inlets.
 - c. Reduce reactor charge rate to 16,000 B/D.
2. A complete steam failure will require a complete shut-down since the recycle compressors, reactor charge pumps and reboiler circulation pumps are steam driven.
 - a. Cut out all fires. Open all air doors and dampers as wide as possible to allow heaters to ventilate by natural draft.
 - b. Shut down all pumps, including Booster Comp. Switch H₂ to Prod. Gas Drum.
 - c. Block in Platformer Reactor System and Towers.
 - d. Reduce excessive pressures to vent or flare.

E. EXPLOSION, FIRE, LINE RUPTURE - ALERT FIRE DEPARTMENT

1. Cut all fires from heaters. If heater or control valves are beyond reach, use main gas valve. Put steam in fire boxes.
2. Shut down and block off Reactor Charge pumps and Hydrogen Booster Compressors.
3. Leave recycle compressors running, if possible.
4. Block the oil or gas flow to the fire or rupture.
5. Get steam hoses directed to the rupture.
6. Depressure unit to flare.

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B. INSTRUMENT AIR FAILURE (Continued)

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