資 料

船舶配管設計電算化와 HICAS-P

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1. 序 論

現在 모든 産業은 大部分 情報 및 Compntor의 時代라 해도 과연이 아닐 정도로 많은生產工程 設計自動化 資材관리 等의 電算化가 洪水처럼 밀려와서 各先進國에서는 造船分野에서 많이 開發되어 實用化되고 있다.

그동안 우리나라도 船殼方面은 設計 및 生產部門에 많이 電算化되면서 實用化되고 있으나 의장부문, 工程관리 資材관리에 있어서는 거의 손을 못대고 있는 형편이 있는데 금반 現代造船에서 設計分野를 電算化하게 되어 日本 IHI 및 Hitach의 電算化 1部를 소개하고 그 內容을 간단히 說明코자 한다.

IHI는 그동안 獨自的으로 여러분야 걸쳐 개발하여 使用하고 있으며 그 代表的인 것은 CADS, SEABIRD 와 PDS, PCS, PFS, PPAC等이 있고 이는 造船(의장, 선각), 船舶, 航空, 土木建築, 化學 Plant 設計技術管理, 資材관리, 原價管理等 범위가 넓으나 여기서는 造船, 船舶과 관계가 깊은 CADS, SEABIRD (Ship Design Engineering Aided by Interactic. Remote Display)等을 概略的으로 紹介하고자 한다.

(1) P. D. S…Piece. Devide Sys.

(2) P. C.S…Piece. Calcolation Sys.

(3) P. F. S…Pipe. Fabrication Sys.

(4) P. P. A. C…Pipe Planning Sys. Aided by Computer

(5) C. A. D. S…Conversational Analyzer & Dratiting Sys.

(6) SEABIRD
- DMS…Data Base Management Sys.
- GLAN…Geometrical Language
- GDS…Graphic Design Sys.
- BAP…Basic Application Program
- POP…Post Processor
- BUS…Business Untility Sys.
- DDGP…Data Distribution and Gathering Program

Hitach에서는 Hitatch自身의 固有의 HICAS를 電算化하여 主로 設計的인것 即 Hard ware보다 Soft ware重點을 둔 HICAS-P를 개발해온 것이다.

HICAS는 HICASS-H, HIZAC, FNC 等의 船殼 Sys. 과 HICAS-P 외 Pipe Design Central Sys. 과 Production Side의 工程 및 資材 Control等의 Subsys. 으로 되여있다. 本稿에서 例擧한 資料中에서 特히 HICAS-P의 概要를 附錄에 收錄한다.

(注解)

HICAS:Hitach Zosen's Computer-Aided Ship-Building System

HICASS-H:Hitach Zosen's Computer-Aided Ship-Building System for Hull Structure

HICAS-P:Hitach Zosen's Computer-Aided Ship-Building System—Piping Subsystem

HICAS-C : Hitach Zosen's Computer-Aided Ship Building System for Basic Design

HIZAC:Hitachi Zosen Auto Coding

FNC:Flat Bar Flame Cutting Sys. by Numerical Control

2. CADS 槪要

造船에 있어서 艤裝設計中에서 큰 比重을 占하고 있는 것이 配管艤裝圖作成과 管一品 製作을 위해서 Data를 作成하는 것이다.

이것은 造船에 있어 配管뿐만아니라 化學 Plant, Turbine, 其他屋內配管의 設計에도 같이 適用될 수 있다.

本 Sys.은 CADS를 이 配管의장도作成과 管一品 Data 作成에 利用하여 設計의 時間短縮과 質의 向上을 目的으로 單純作業의 機械化와 精度向上에 依해 設計作業을 餘裕를 갖게 하고, 設計者가 創造的 活動이나 總合的 判斷을 必要로 하는 作業에 專念할 수 있게 하는데 目的을 둔 Sys.이다.

의장도 作成은 從來標準化 또는 自動配管 Logic에依한 處理에 의해서 省力化가 行하여 졌지만, 이 作業은

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상당한 圖面處理를 包含하고 있다.

即 人間의 判斷에 依한 作業展開가 主로 되는 것이다. 이 手作業補助로서 CADS를 使用하므로서 作業의 單純化를 企圖할 수 있게 되었다.

한편 艤裝圖作成後의 一品製作(管 Support等)情報나 Material Control 情報의 Imput Data作成에 대단한 勞力과 神經을 써서 개발된 것이나 이 Sys.로서 이들Data를 自動的으로 編集하므로서 人間의 손에 의한 作成은 全혀 不用하게 된다.

2-1. 配管 Sys.의 特徵

CADS의 共通的으로 말할수 있는 特徵以外에 配管으로서 特記해야 할 特徵은 다음과 같은 것이 있다.

(1) 三面圖(平面圖, 側面圖,斷面圖等)의 取扱에 依하여 三次元空間의 配管設計가 이루어 진다.

(2) Pipe의 兩端點 및 曲點만의 Input로서 Pipe Line을 그릴 수 있다.

(3) Pipe屈曲點의 曲率計算, Pipe長의 Rounding Pipe을 그 走行方向을 自動的으로 各軸方向으로 修正하는 機能等을 가지고 있다.

(4) 任意斷面이 自由로히 拔出하여 Pipe等는 부분의 Check, 修正追加等을 容易하게 할 수 있다.

(5) 配管의 Back Ground가되는 선체구조 等은 背景書로써 使用하므로 拘束條件의 인식이 간단히 안 수 있다.

(6) 新規設計도 標準을 Base로한 組合設計도 可能하다.

(7) 艤裝圖의 作成에 의해 一品製作 Data가 自動的으로 만들어진다.

2-2. CADS配管設計 Sys.의 位置配列圖

配管設計全體에서 본 Sys,의 配列圖는 Fig.1.과 같다. 系統圖, 機器配置圖(全體裝置圖), 配管構想圖, 必要한 背景書, 系統別 Practice, 部品 Master가 準備되여 있다. 이들 Data를 根本으로 區劃單位(艤裝圖單位의 區劃)의 總合圖作成에 依해 配管取付圖및 一品製作 Material Control情報가 作成된다.

2-3. 配管設計作業內容

設計作業의 進行方法으로 다음 3段階가 있다.

(1) 標準을 Base로 하여 標準을 選擇하고 組立하여 本船設計를 하는 것.

(2) Type Ship을 Base로 하여 이것을 修正, 組立하므로서 本船設計를 한다.

(3) 新規로 設計를 한다.

以上 어느것인가, 또는 組立에 따라서 設計作業이 進行되지만, 本 Sys. 은, 이들 어느 Case에도 適用된다.

3. SEABIRD Sys.의 概要

3-1. System의 構成

SEABIRD의 Soft Ware는 Fig. 1에 表示한 바와 같이 Data 處理 一般에 必要한 Program과 設計에 要하는 Program으로 크게 分類한다.

그리고 後者는 設計에 共通 Program와 特定業務(船殼設計든가 艤裝設計…等) 專用 Program으로 分類된다. 機能面에서는 汎用 On-Line Data-Base管理 Sys. 圖形處理 Utility, 作劃 Utility, Business Utility等으로 分類된다. 一方處理 形態에서 即時 處理와 一括處理로 分類할 수 있다.

(2) Hard-Ware

SEABIRD Hard Ware構成을 Fig. 2에 表示한다.

3-2. Sys.의 機能과 特徵

SEABIRD를 構成하고 있는 7가지 Sub-Sys.의 機能, 特徵을 以下에 설명하면

(1) D.M.S.(Data-Base Management Sys.)

System의 中核을 이루고 있는 것으로 Coment를 使用하여 다음과 같은 機能을 利用할 수 있다.

① Terminal management…… On-Line에 있어서 端末機의 制御를 한다. 現在 使用되는 端末機는 character display, Typewriter等이 있다.

② Data-Base Management……

Data의 蓄積, 檢索, File更新 管理를 한다.

③ Text editing

Data-Base에 蓄積된 Data의 修正, 追加, 削除, 演算等을 한다.

④ Procedure Management

Comment에 依해서 一連의 作業順序를 自動的으로 記錄하고 또 實行을 一개의 Comment에 依해 하게 된다.

⑤ Romote Job Entry

Program의 實行을 遠隔地에서 端末機를 通하여 行하고 出力을 얻는다.

(2) GLAN(Geometrical Language)

圖形處理를 Computor로 할 경우 Graphic Display 裝置를 使用해서 直接圖形을 定義하는 以外는 一般的으로 圖形을 言語形式으로 表現하고 Process에 걸어서 自動製圖機를 制御하기 위해서 點列로 落下하고 있다. 本 Sys. 은 이 Process를 GLAN이라 稱하고 獨特한 言語形態를 가지며 또 다음과 같은 特徵을 가지고 있다.

① 曲面을 除하고는 모든 3次元의 圖形이 定義될 수 있다.

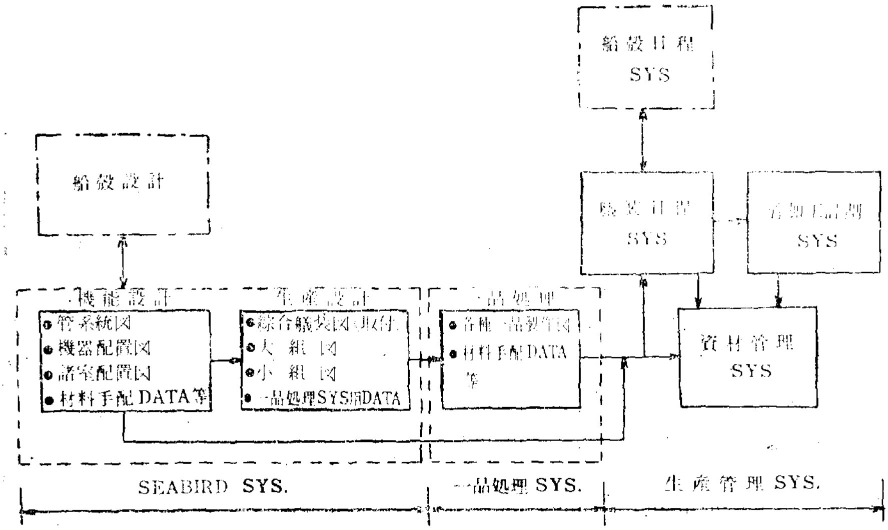

Fig. 1-a. Composition of SEABIRD-Fitting (Job Flow)

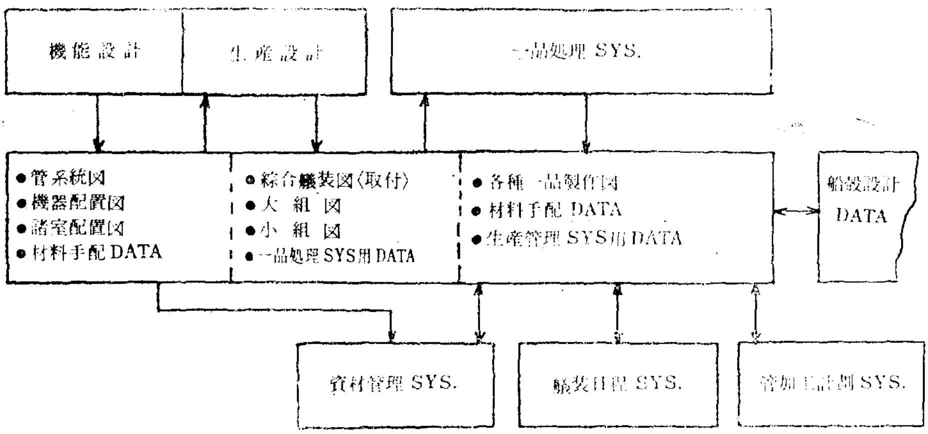

Fig. 1-b. Composition of SEABIRD-Fitting (Job Flow)

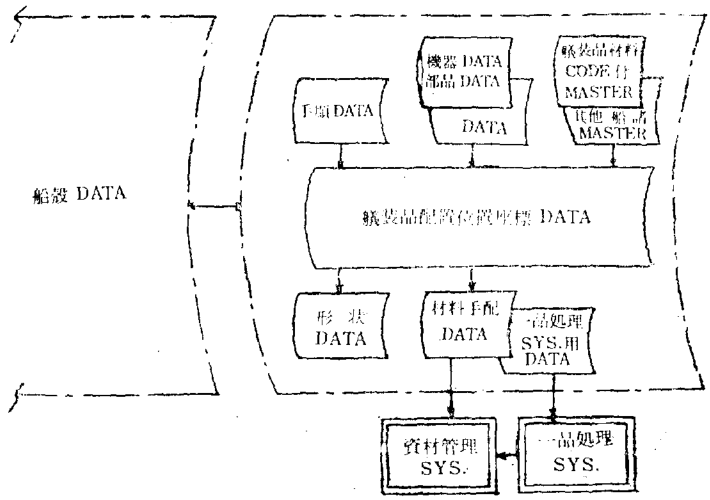

Fig. 1-c. Main Data File Conposition of SEABIRD Fitting

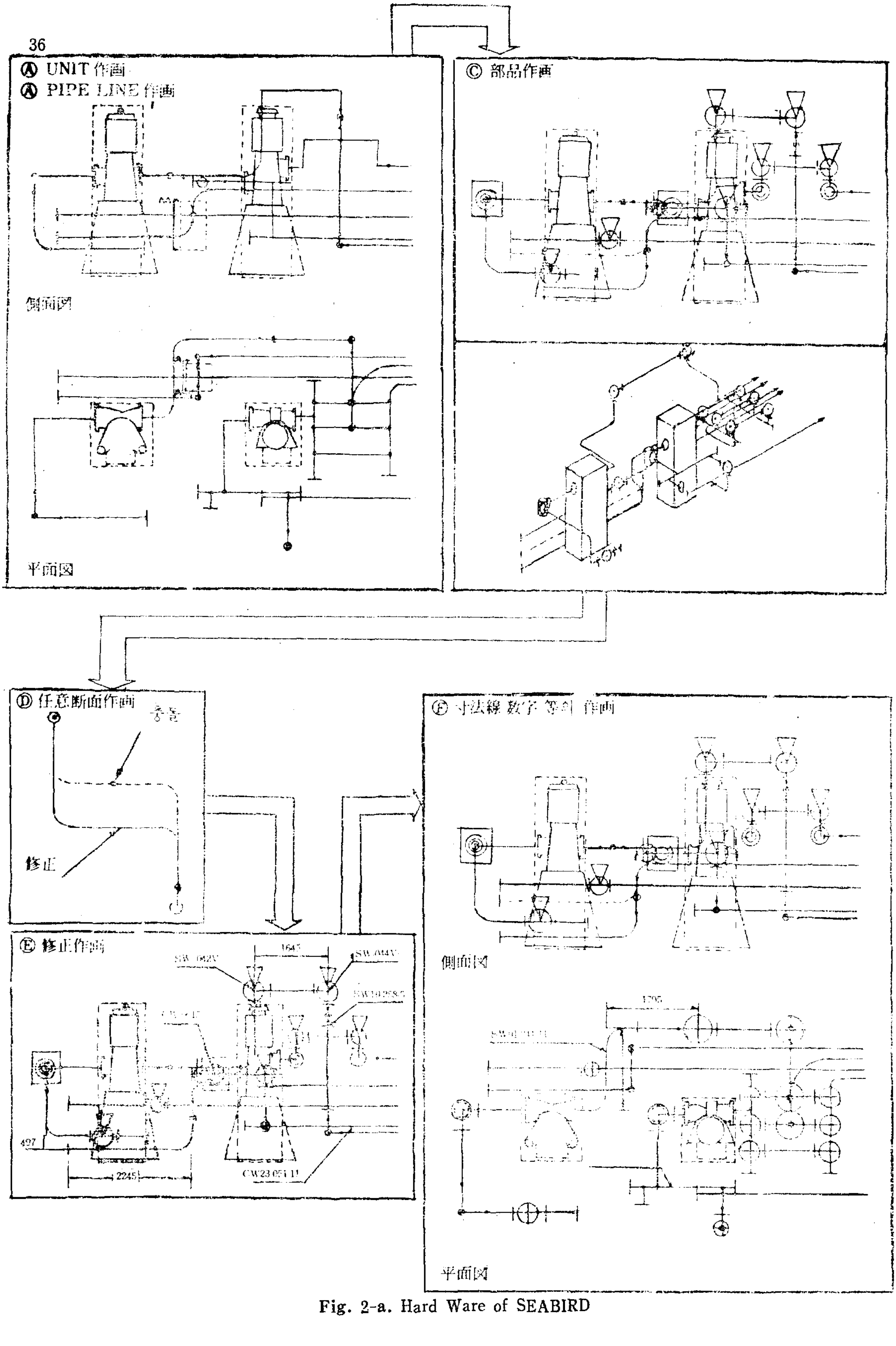

Fig. 2-a. Hard Ware of SEABIRD

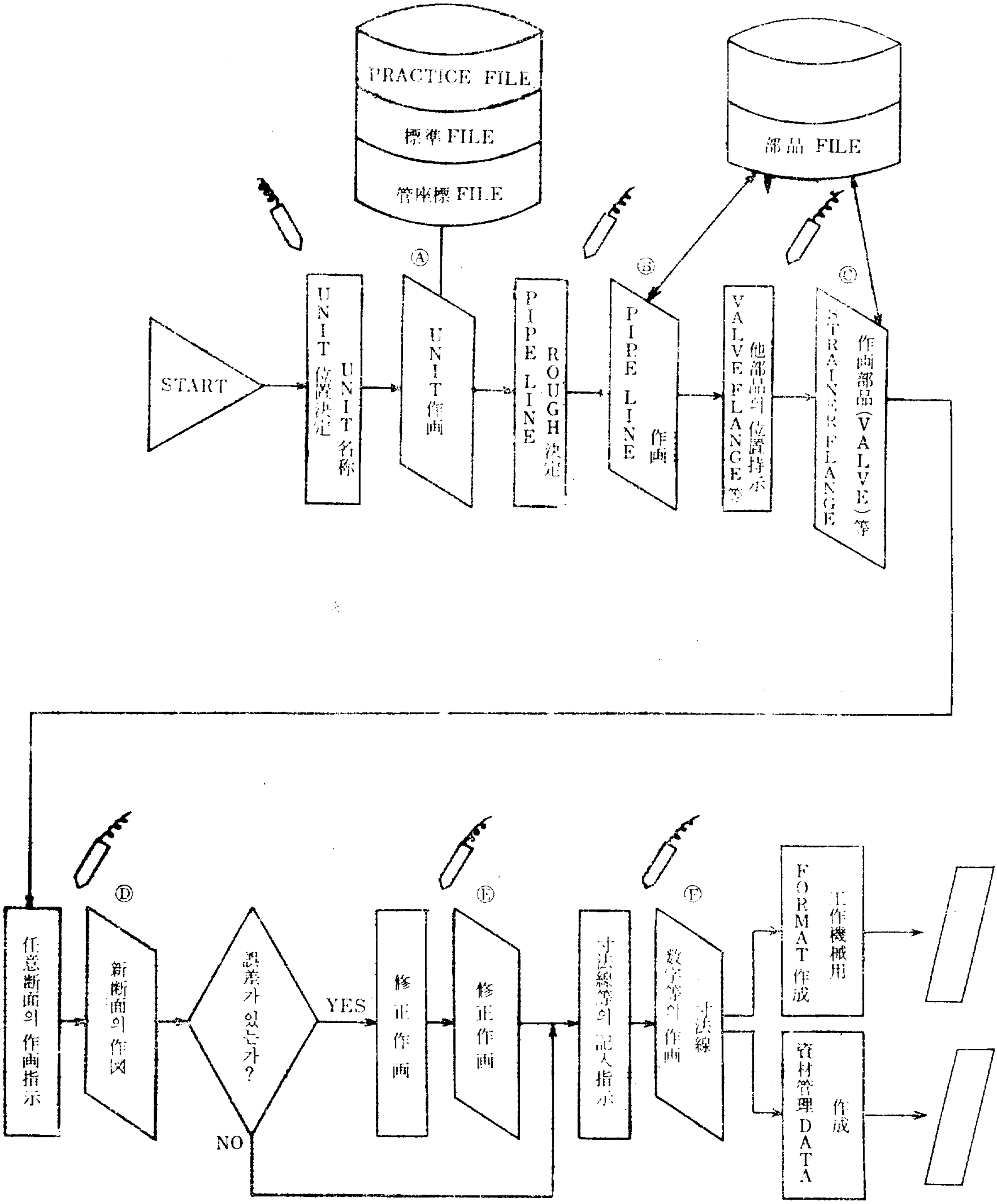

Fig. 2-b. Hard Ware of SEABIRD

② 自由 Format形式의 記述이 可能하다.

③ Scalar演算을 爲한 言語를 준비하고 있다.

④ 圖形을 構成하는 言語集을 登錄하므로서 以後의 Barometer의 指定만으로 同一 Pattern의 實行이 可能하게 된다. 現在 約 70個(GLAN)의 言語를 준비하고 있다.

(3) G. D. S. (Graphic Design Sys.)

圖形을 定義하는 경우에는 Graphic Display裝置를使用해서 直接圖形으로서 入力할 수가 있다. G. D. S.를 利用할 경우는 첫째 必要한 Data를 Data Base에서 D.M.S.를 使用해서 Data變換 Program를 實行하므로서 G.D.S.의 Working File에 Data를 보낸다. 다음에 再次 D.M.S.를 使用해서 G.D.S. Process를 Core에 Load한다. 利用者는 G.D.S. Comment(MENU)를 使用하고 圖形의 生成과 修正을 畵面上에서 行한다. 일이 終了하면 Working File의 Data Base에 Data를 轉送한다.

G.D.S.의 定義의 Comment는 GLAN 言語와 1對 1로서 對應되어 있고 Graphic display裝置를 使用해서 作成한 圖形作成順序가 GLAN 言語로 쓰여진 MAGRO의 形式으로서 뽑아낼 수가 있다. 이機能을 學習機能이라 부르고 있다. 이와 같은 圖形의 언어집단이 豐富하면 Graphic display裝置를 利用하여 그때 그때의 形便에 따라 圖形을 作成하지 않고 언어집단을 實行하므로서 한꺼번에 圖形을 인을 수 있다.

(4) BAP (Basic Application Program)

BAP는 GLAN이나 GPS와 같이 單體의 圖形을 定義하여 處理하는 것이 아니고 Control Barometer에 依해서 對象 File 全體의 圖形處理, 編輯을하는 Program群이다. 이들 Program은 對象物을 限定하지 않고 極히 汎用的인 것이다. 例를 들면, Tubimation(어느母線의 兩端의 任意圖形을 始點側에서 終點側에까지 母線에따라서 移動시킨 경우의 移動軌跡을 求한다). Program은 形鋼, 其他 다른 種類의 圖形處理에 利用할 수 있다.

(5) POP (Post Processor)

Data Base로 蓄積된 圖形를 Data數値制御機械에 주기전에 이 Program을 實行하여 機械에 맞는 Code로變換한다. 現在 Protter 自動製圖機 其他 各種數値制御機에 利用하고 있다.

(6) BUS (Business Utility Sys.)

大容量 Data를 編輯, File再編成, Report Generation 等의 일을 Batch Mode로서 實用한다. 汎用的으로 作成되었기 때문에 簡單한 Barometer 指示만으로 實行할 수가 있다. Barometer의 指示에 依해 여러가지 形式의報告書가 作成 可能하다.

(7) DDGP(Data Distribution and Gathering Program)

遠隔地에 있는 Mini Computor를 中心으로한 System에 Data를 傳達하는 하거나 逆으로 그쪽에서 Data를 收集하는 Program이다.

3-3. Data Base

SEABIRD의 Data base는 特別한 構造를 갖이지 않고 단한개의 record가 80文字로 된 sequential file이 基本이 된다. 이形式을 採用한 理由를 以下에 적어보면

1) 單純하여 누구나가 理解하기 쉽다.
2) Hard Ware에 依存하지 않는다.
3) 非定型的으로 發生하는 Data를 柔軟하게 處理할 수 있다.
4) 旣成 Module과의 Interspace가 容易하다.
5) 旣存 Data를 有効하게 利用할 수 있다.
6) 開發이 容易하다.
7) On-line의 Performance가 상승한다.

4. 艤裝設計 Sys.에 適用(SEABIRD-Fitting)

여기에서는 SEABIRD Sys.을 Base로 하여 開發한 의장 설계 Sys.에 대하여 논하기로 한다. 그리고 여기서 말하는 艤裝設計는 甲板部 居住區劃 機關部 및 電氣部를 包含한다.

4-1. 範圍와 構成

SEABIRD Sys. 開發以前에는 의장설계관계의 Sys.로서 各種艤裝品(管, 管支持臺, 사다리, 通風 Trunk, 木艤裝, 電線)等의 一品製作圖의 作成, 材料集計 및 生産管理 Sys.에로 情報提供을 主目的으로 한 一品處理 Sys.이 있었다. 이것은 生産관리의 Sys.이 一環으로써 艤裝品의 標準化種類의 削減을 第一目的으로 하고 併行해서 반복이 많은 一品製作圖 作成의 省力化를 第2의 目的으로 한 것이다. 그러나 이 Sys.은 어데까지나 綜合의장도(取附圖)가 旣히 준비된것을 前提를 하고 있기 때문에 Input의 勞力이 比較的 크고 또 Manual로서 준비된 圖面에서 材料를 算出하여 Input 하기 때문에 圖面과 物件이 一致하지 않은 경우도 있고 Computor에서 나온 所要材料와 圖面과의 照會에 時間이 要한다.

또 의장품을 取附하는 時點에서 처음에는 그의 mistake가 발견되는 것도 있다. 그래서 本艤裝設計 Sys.에서는 機能設計단계에서 綜合艤裝圖作成 및 製作圖의 作成까지 全處理를 包含하여 의장총합 정보처리 Sys.로서 上述의 旣存 Sys.와 SEABIRD Sys.를 統合化를 계획했든 것이다. 機能設計에서 生産設計까지의 SEABIRD 汎用 Sub Sys.을 中心으로 하고 一品處理는 旣存의

一品處理 Sys.으로서 構成하고 있다.

그 構成을 Fig. 1-a및 Fig. 1-b에 表示하였다. 나아가서 一品處理 Sys.은 SEABIRD의 Data Base를 中介로하이 Interspace가 되어 있다. 또 量的으로는 艤裝品의 大半을 점하는 管은 管自動一品制 Program에 따라서 兩者의 連繫가 되어 있다.

APPENDIX

1. Outline

HICAS-P (Hitachi Zosen's Computer-Aided Shipbuilding System-Piping Subsystem) is one of the subsystems of HICAS, an integrated data processing subsystem developed by Hitachi Zosen for its own shipbuilding purpose.

The subsystem stores all information concerning ship piping in its data base, from preliminary design to production and installation stages, and supplies, as required, useful data including drawings and administrative information for different stages of pipework.

Hitachi is applying the System satisfactorily to all the vessels built at its Ariake and other shipyards.

Functions of HICAS-P include:

1.1. Automatic Drafting of Various Piping Drawings

With a simple set of instructions for output drawings, the following drawings are taken out through either a drafter or a dotprinter.

- Schematic piping diagram
- Reference drawings for fitting design (including cabin arrangement)
- Machinery and equipment arrangements
- Generalpiping arrangements(comprising plan and cross-section)
- Detailed piping arrangements (comprising, cross-section, partial enlargement, etc.)
- Digrams for pipework(with respect to individual pipelines or hull blocks)
- Isometric piping diagrams
- Pipe piece drawings

These drawings on which the relative positions of pipelines and the piece numbers are indicated can be directly used for fabrication and installation of pipes.

1.2. Efficient Automatic Design Functions

HICAS-P has the following automatic design functions:

(a) Optimum Route Calculation Function

Given the pipe passages and pipeline terminals, the System automatically calculates the shortest pipe route with minimum number of bends. The route is automatically drafted for use as schematic piping diagram.

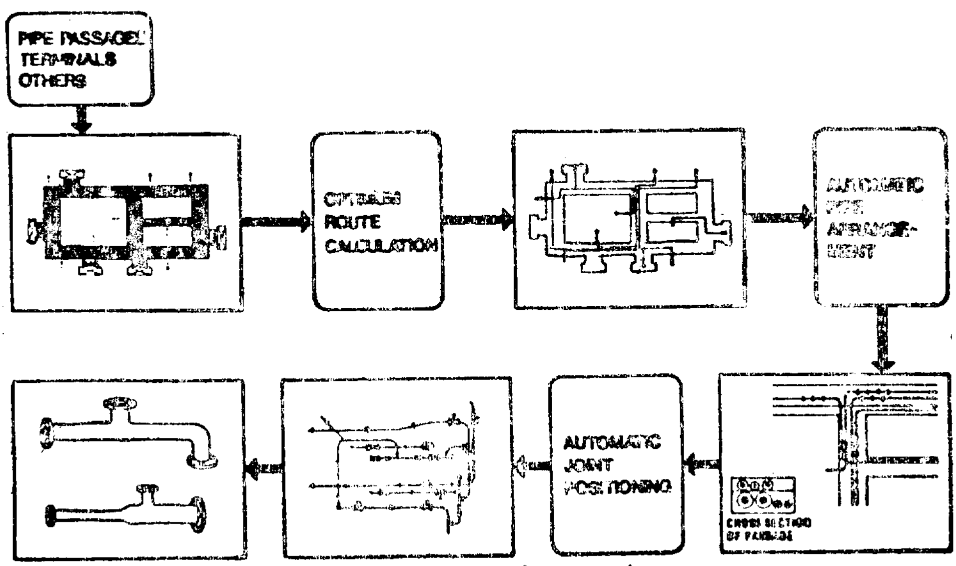

Fig. 1. Automatic Design Functions

(b) Automatic Pipe Arrangement Function

This function arranges pipelines in each optimum route calculated by the above-mentioned function or given manually so hat they do not interfere with each other. A great care is taken for the installation of pipes in determination of individual pipe location.

(c) Automatic Joint Positioning Function

This function automatically breaks down a pipeline, given as input, into pipe pieces or, in other words, automatically generates pipe joints. Since all operating conditions required for piping are incuded in this process, no pieces are produced which cannot be fabricated.

1.3. Function of Direct Entry of Drawings

HICAS-P has an interactive input system utilizing a front-end computer, a digitizer,graphic display and function keyboard, which the designer uses to read data from piping arrangements while carrying on a dialogue with the computer. Input is accomplished quickly and easily, and the operator is promptly informed of any mishandling. The system thus reduces substantially input load while simultaneously allowing early detection of data errors.

1.4. Provision to Supply Various Lists Whenever Required

The designer can easily obtain, besides drawings, the following lists as required by giving simple instructions for output.

- Order specifications of fittings classified by individual manufacturers
- Lists of fittings classified by diagrammatic arrangements
- Quantitative lists of general fiitings
- Indexes of pipe piece drawings
- Quantitative lists of heat insulation material
- Data base monitoring lists

1.5. Provision to supply complete information on fabrication and Istallation

It further provides NC pipe bending system, pipe shop production system and installation job order system with significant information on pipe fabrication.

1.6. Complete Checking Functions

HICAS-P performs the following checks during

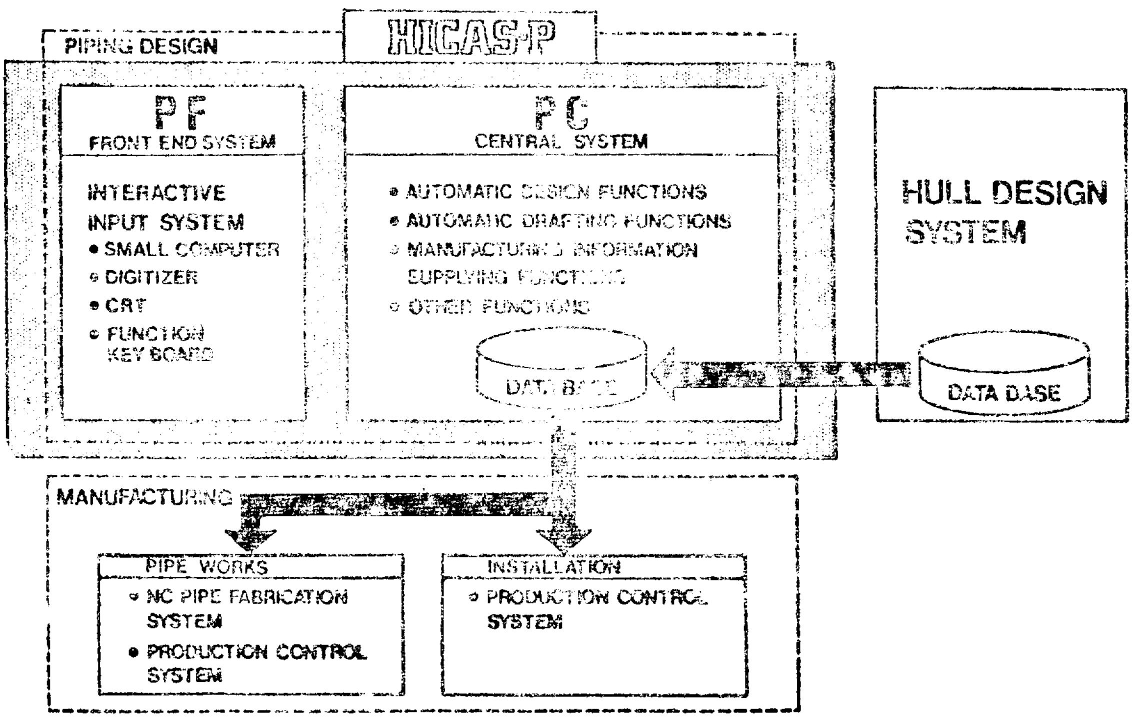

Fig. 2. System Composition

either input processing of pipeline data or automatic joint positioning, and theroby eliminates a number of design errors:

- Interference analysis(Interference between pipes, between pipes and hull structures and between pipes and machinery or equipment; messages for detection are supplied.)
- Checks of pipe benders
- Checks of limitations of plating, lining and other pipe conditions
- Checks of logicality of input data
- Checks of materials used, etc.

2. Composition of the System

HICAS-P consists primarily of front-end system (PF), central system (PC) and data base. (Fig. 2)

2.1. Front-End System (PF)

PF is a system to read data directly from general or rough piping arrangements, and the operation is performed through interactive dialogues with the front-end computer. Main peripherals include adigitizer, graphic display, function keyboard and magnetic tape, which are controlled by the front-end computer.

Entered data are stored on the magnetic tape and fed to PC. Data taken in incude:

(1) Data for hull structure
(2) Data for pipelines (if entered from general piping arrangements)
(3) Data for pipe pieces (if entered from detailed piping arrangements)

2.2. Central System (PC)

PC may be operated on the following seven stages:

(1) Initial Data Preparation of Standard Parts(First Stage)

Peqmanent data common to all ships are prepared. By permanent data are meant the dimensions, weights materials and graphic symbols of parts.

(2) Processing of Digrammatic Arrangements(Sec-

Table 1. Program Table of Central System

No.	Program Package \ Type of System	P_1	P_2	P_3
1	Initial Data Preparation for Standard Parts	○	○	○
2	• To process Material Lists of Pipelines	○	○	○
	• To process Special-Order Fittings	×	○	○
3	Processing to back up Piping Arrangements			
	• To transform(data for Hull Structure of certainsystem into the form that conforms to HICAS-P	×	○	○
	• To make the Supplementary Data for Hull Structures which cannot be transformedby the above method	×	※	※
	• To make the Geometric Data for Each Machine referring to "Machinery and Equipment Arrangements"	×	※	※
	• To make the Symbol Data for other parts to be shown in"General Piping Arrangements" and in "Detail Piping Arrangements"	×	※	※
4	"Optimum Route Calculation"	×	×	○
5	"Automatic Pipe Arrangement"	×	×	○
6	Pipeline Processing			
	• Automatic Joint Positioning	×	○	×
	• Detailed Piping Arrangement Drafting	×	○	×
7	Pipe piece Processing			
	• Drawings and InJormation for Pipe Pieces Manufacturing	○	×	×
	• Administrative Lists	○	×	×

○ stands for required program and × for non-required program * stands for etiher

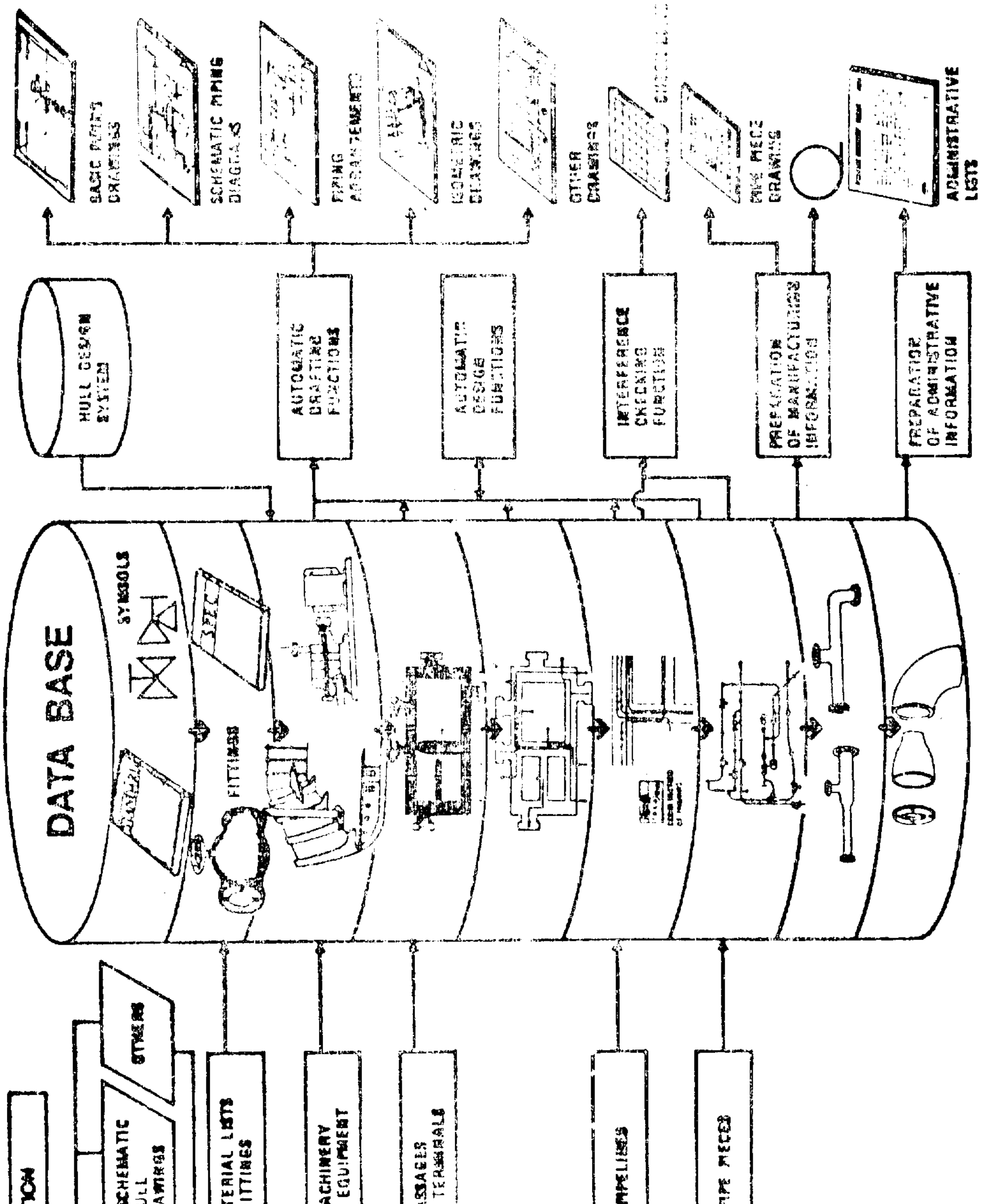

Fig. 3. System Flow

ond Stage)

Processing for individual ships starts at this stage, where special-order fittings and material lists of individual pipe-lines are separately handled.

(3) Processing to Back up Piping Arrangements (Third Stage)

The hull structure data are mainly provided from the data contained in the data base of hull system. Then, the supplementary data for hull structure, the geometric data for machines and other equipment, and symbol data for other parts are supplied.

(4) Optimum Route Calculation (Fourth Stage)

This is perfomed depending on the following two kinds of data;

- terminals of pipelins
- pipe passages

and "schematic piping diagram"is drafted.

(5) Automatic Pipe Arrangement(Fifth Stage)

This function determines the final location of each pipeline within the optimum pipe routes.

(6) Pipeline Processing(Sixth Stage)

This stage is the core of PC. The pipeline data are entered to accomplish automatic joint positioning and to supply various drawings related.

(7) Pipe Piece Processing (Seventh Stage)

Final information for fabrication is mainly provided. The output includes pipe piece drawings and quantitative lists of parts.

HICAS-P may be differently set out from the standpoint of mode of use.

P_1…… 7th stage only

P_2…… 6th and 7th stages

P_3…… from 4th to 7th stage

2.3. Data Base

The data base is under the control of the unique data management system (developed by Hitachi Zosen for its own shipbuilding use) of HICAS, and independent of application programs.

It therefore flexibly permits addition of new functions in the future.

Each individual item of data, having its own characteristics, is represented in the most suitable structure with a view to higher access efficiency.

3. Input, Output and Data Bsse

Fig. 4 shows the piping design procedures and the relationship between the input, output and data base of HICAS-P.

Further details of each aspect follow.

3.1. First Stage (Initial Data Preparation for Standard Parts)

(1) Input

Standards of parts are defined for use in the following two categories:

a. Data for the attributes of parts

These data concern the name, standard, order number, dimensions, weight, pressure-registivity and grapic symbol of each part.

b. Data for the graphic symbols of parts

HICAS-P has a function to define as desired the graphic symbol of each part. The graphic symbol is separately defined by graphics processing language.

(2) Data Base

Entered data are stored in PSD file represented in a four-level table structure. The data are accessed by DAM (direct access method). The required capacity is about 3 MB in case of Hitachi Zosen.

(3) Output

The following information in supplied to facilitate verification and preservation of the input data:

a. Input data lists

b. Monitoring lists of input data

c. Diagrams for verification of graphic symbols of parts.

3.2. Second Stage(Processing with reference to diagrammatic arrangements)

(1) Input

Input data picked up from diagrammatic arrangements consists of the following two elements:

a. Material lists of each pipeline

The data cover each pipeline and pipe piece. The designer has only to define the key name of the material lists when entering the data, or need not indicate the names of individual parts.

Data to be incorporated the material lists include the name pressure-resistivity, test pressure, plating, coating, X-ray test results and heat insulation etc.

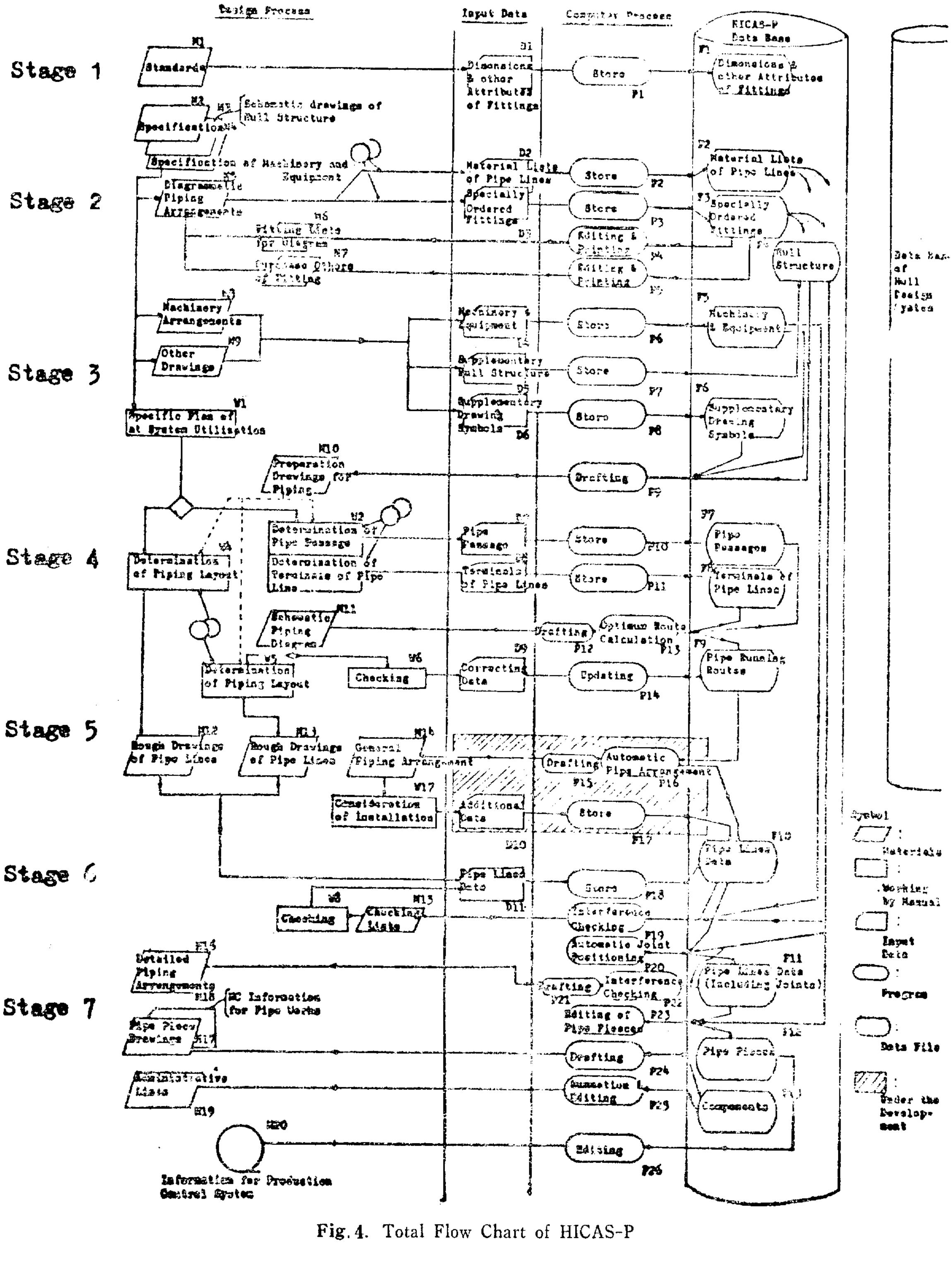

Fig. 4. Total Flow Chart of HICAS-P

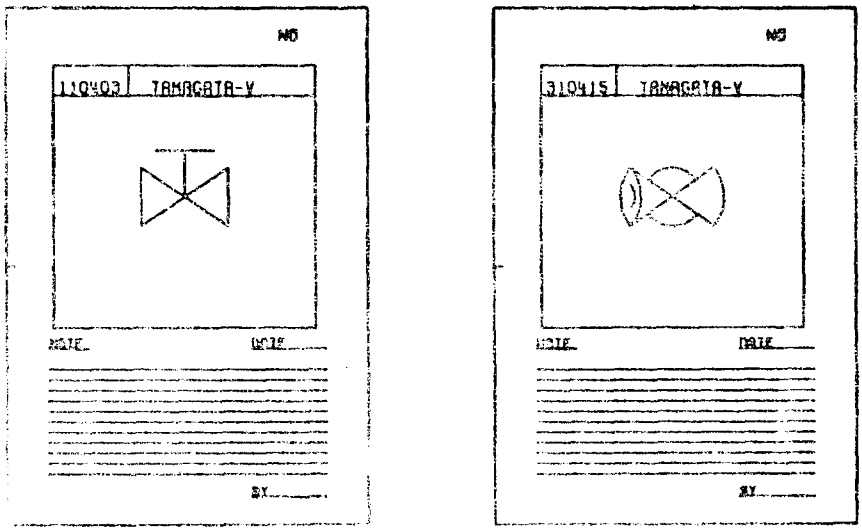

Fig. 5. Drawing Symbols

of each part.

b. Data for special-order fittings

All special-order fittings, including valves, cocks and penetration pieces fall under these data. Information to be entered consists only of the piece number and part name.

(2) Data Base

Material lists are stored in PLS file having a three-level lists structure,and data for special-order fittings in PFT file having a four-level list structure.

Both files are accessed by DAM. The required capacity is about 0.2 MB/ship for PLS and about 1 MB/ship for PFT file.

(3) Output

a. Material lists of each pipeline

They can be turned out when the data are entered or at any subsequent time.

b. Order specifications of fittings

The specifications are edited with respect to each manufacturer on whom the orders are placed. All the attributes of individual parts, including material quality and pressure-resistivity, are printed.

c. Lists of fittings classified by diagrammtic arrangement.

These are lists of special-order fittings classified by each piping diagram, and the contents are more or less the same as those of order specification.

3.3. Third Stage(Proces sing to back up piping arrangement)

(1) Input

Input data at this stage consists of three elements, i.e., the supplementary data for hull structure(accommodation quaters walls etc.),the geometric data for machines and equipment(shown on general piping arrangements and other drawings) and symbol data for other parts (used only for drawings).

(2) Data Base

Data for hull structure and its supplementary data are stored in a direct access PSH file, symbol data are stored PSD file as already described, and the goemetic data are stored in certain temporay file.

The required capacity for PSH file is about 0.5 MB/ship

(3) Output

The output at this stage consists of input data lists and various drawings, such as cabin arraangements and machinery and equipment arranements.

3.4 Fourth Stage(Optimum Route Calculation)

(1) Input

a. Data for pipe passages

"Pipe passage" is the space within which pipelines will be arranged, and the space is made up of a series of cuboids. The data which are subject to obstructions, consist of the name of each node, span between two nodes and each cross-sectional area of each pipe passage.

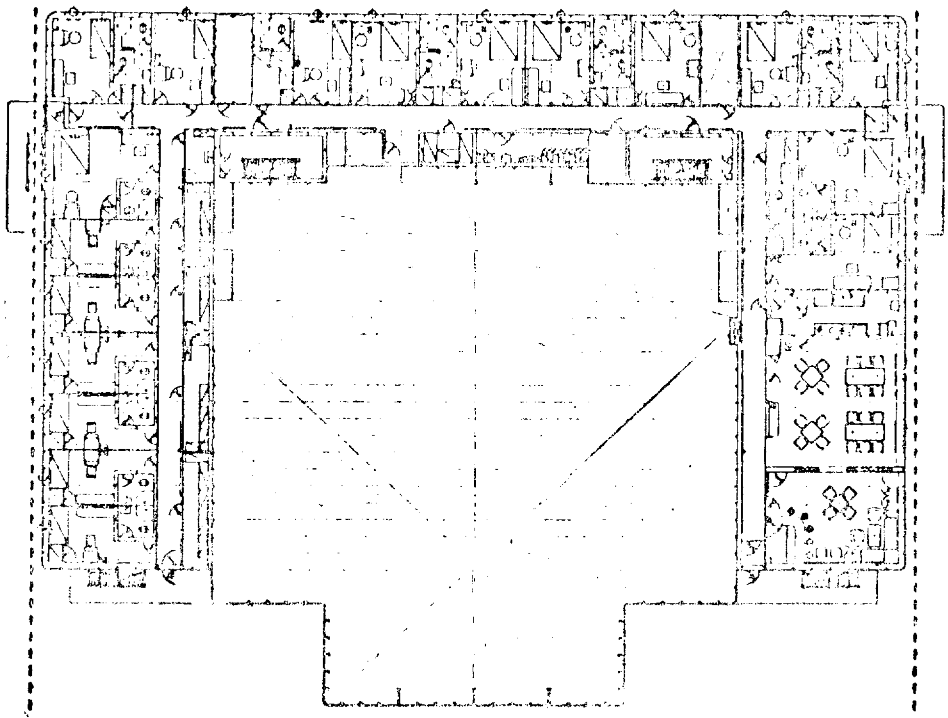

Fig. 6. Accommodation Plan

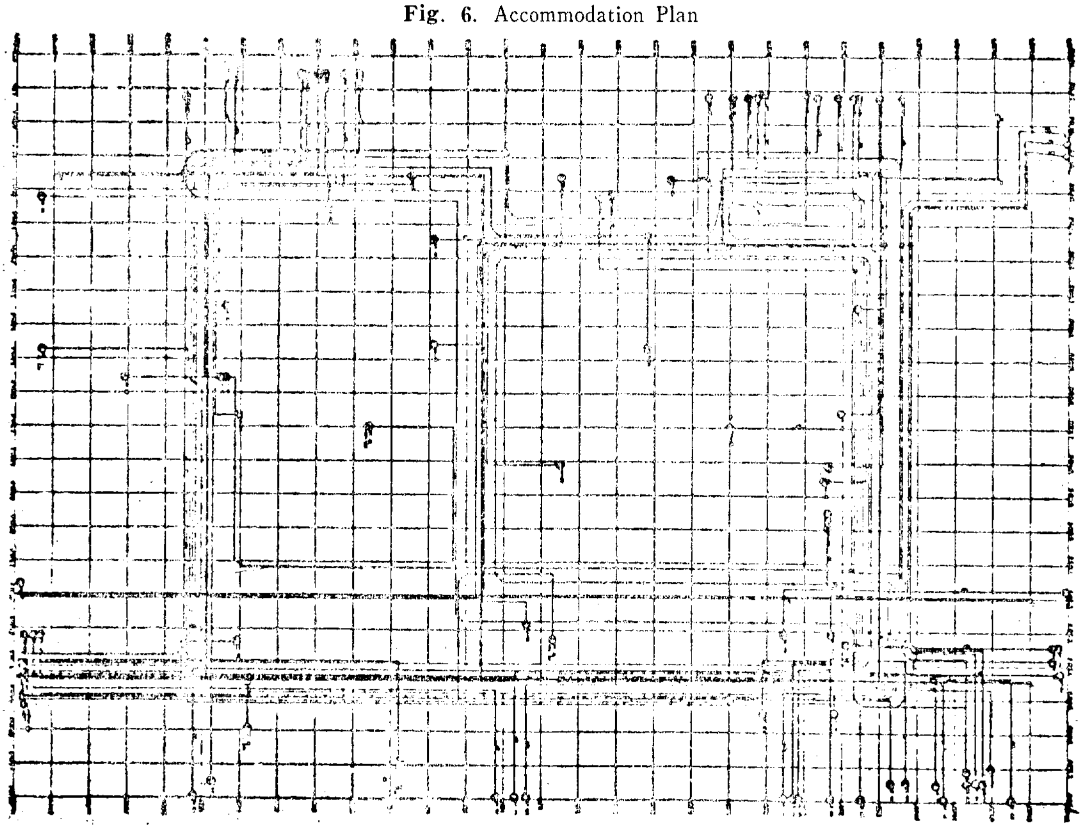

Fig. 7. Schematic Piping Arrangement

b. Data for terminal points of individual pipelines.

They are picked up from the diagrammatic arrangements and machinery and equipment arrangements.

(2) Data Base

Data for pipe passages and for terminal points are respectively stored in PRT file and PTL file.

A sequential file is assigned to either of them, and the required capacity is about 0.1 MB/drawing each.

(3) Output

Data for optimum routes calculated are stored in POT file and used to obtain the schematic piping diagrams through the drafting function.

These drawings are used as reference materials, when designers draw general piping arrangements manually.

3.5 Fifth Stage(Automatic Pipe Arrangement)

(1) Input

Input data at this stage consist of the above-mentioned POT file and the location of each valve.

(2) Data Base

POT file is also a sequential file, and its required capacity is about 0.1 MB/drawing.

(3) Output

The final location of individual pipelines is determined after this processing.

The output, called the pipeline data, are stored in PMA file which has a DAM-based six-level list structure, and the required capacity is 0.5 MB/drawing. Further, general piping arrangements are supplied through the drafting function.

3.6 Sixth Stage(Pipeline Processing)

(1) Input

Input at this stage included two kinds of data, one is for hull structure and the other is for the pipelines The latter may be made manually or through automatic pipe arrangement as described under 3.5, and they represent definitions of points on the pipelines.

Each point is defined in terms of coordinates and status, and each series of points is defined in terms of sequence.

(2) Data Base

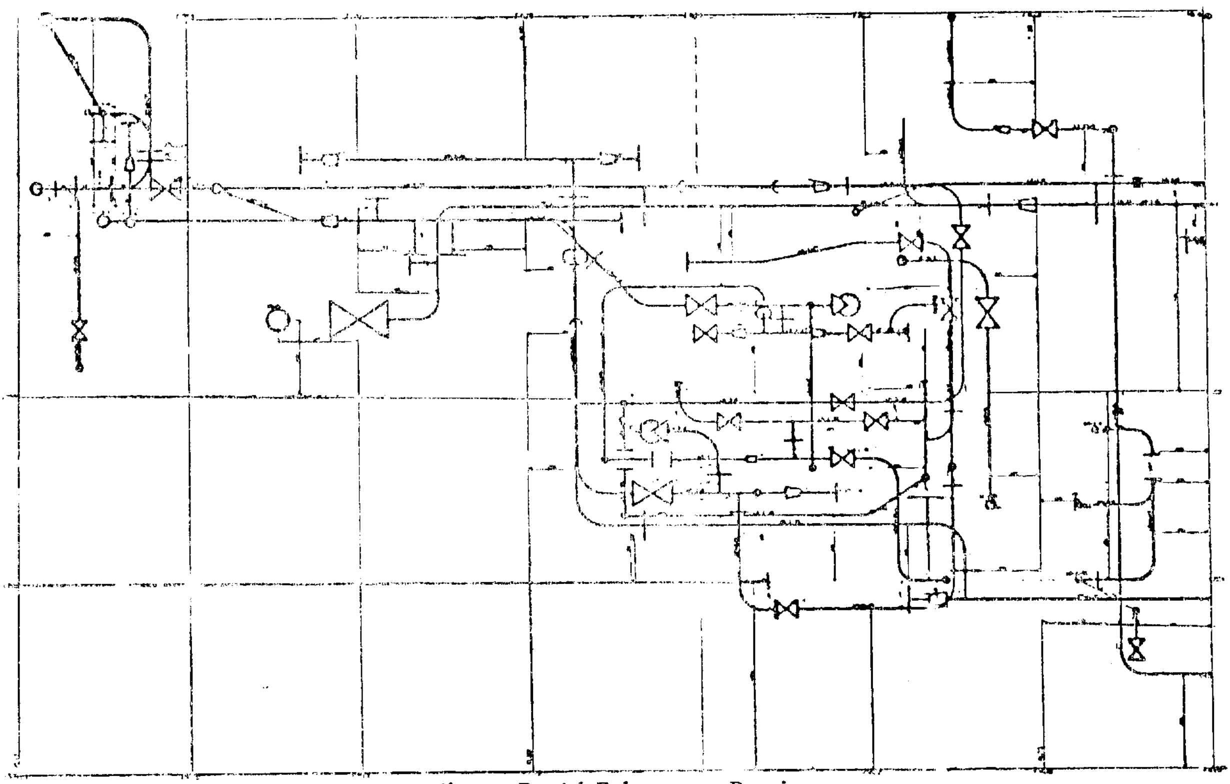

Fig. 8. Partial Enlargement Drawing

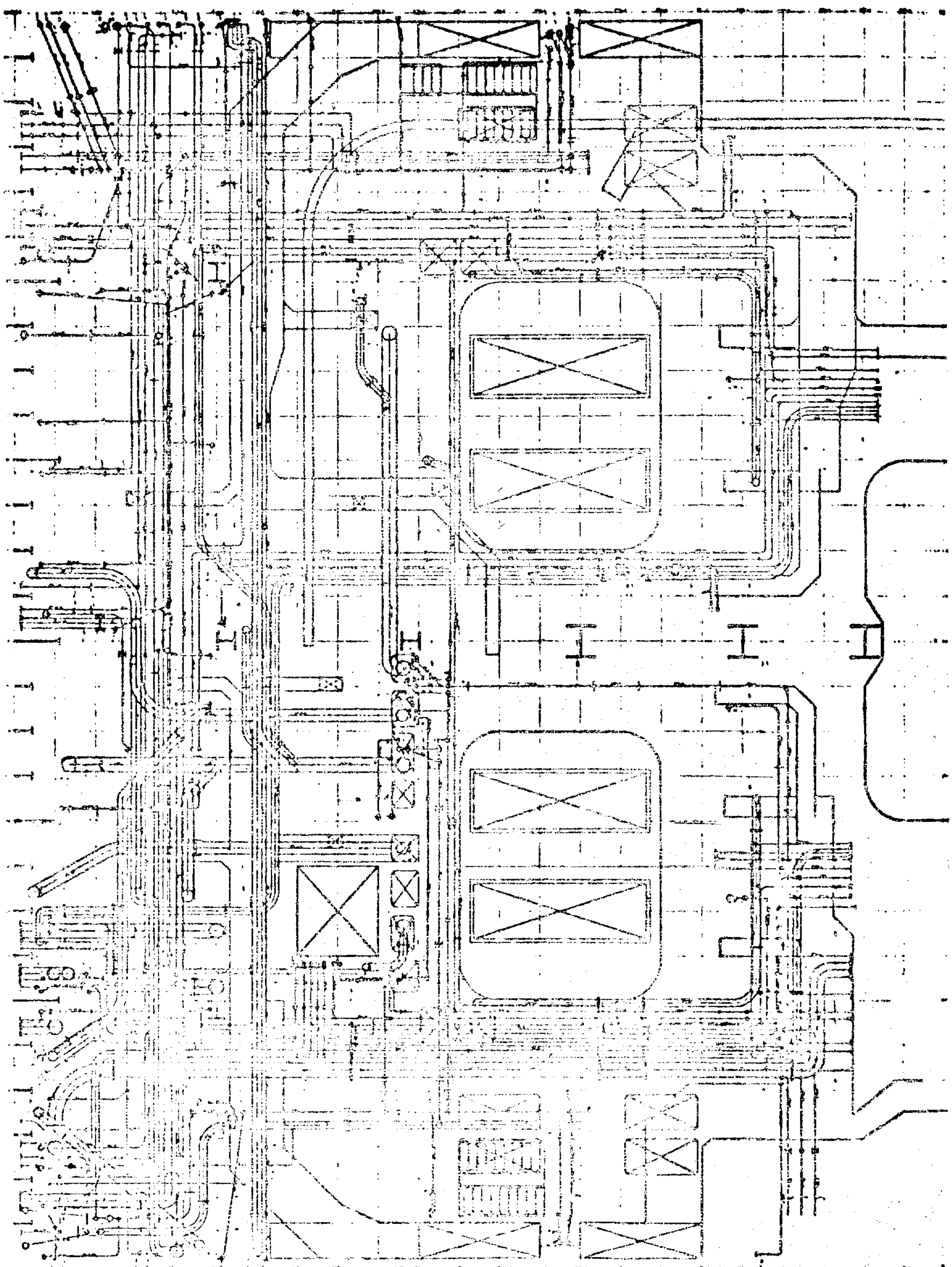

Fig. 9. Detailed Piping Arrangement in Engine Room

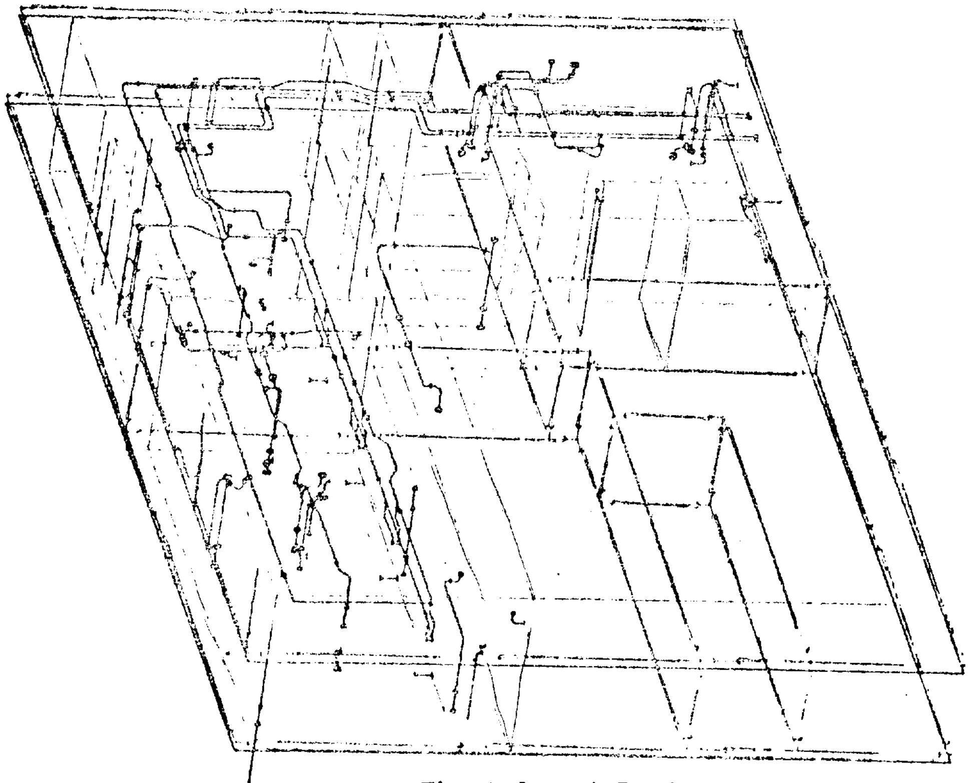

Fig. 10. Isometric Drawing

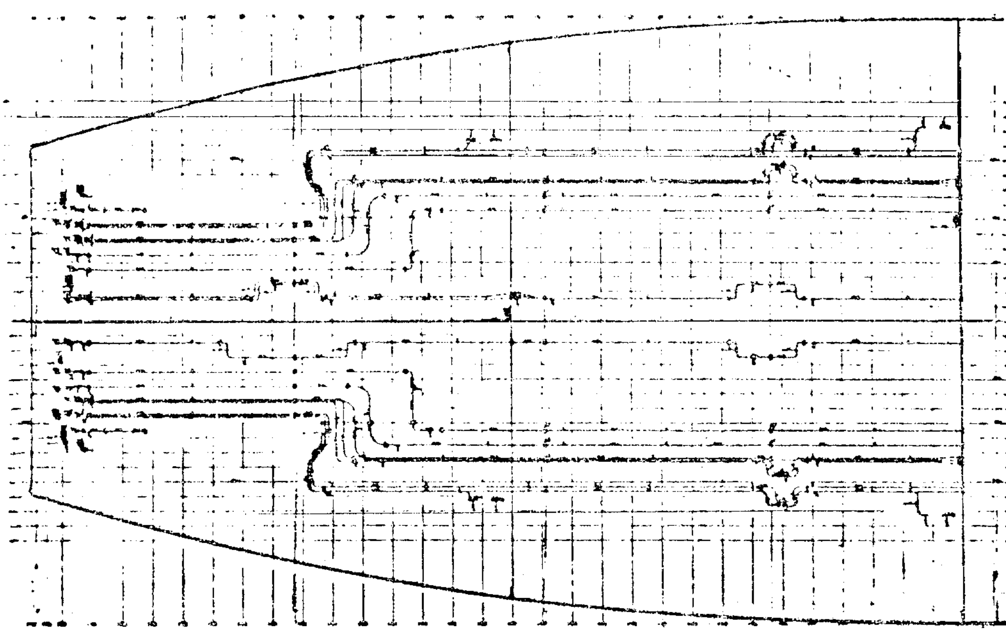

Fig. 11. Detailed Piping Arrangement in Double Bottom of Bulk Carrier

Refer to (3) Output under 3.5.

(3) Output

The output at this stage consists of input data lists and detailed piping arrangements obtained by autom atic joint positioning function.

3.7 Seventh Stage(Pipe Piece Processing)

(1) Input

The input at this stage is either of the following set of data, depending on whether the use of the system is continued from the sixth stage (from PII) or starts at the pipe piece processing stage(from PI):

a. Pipe piece editing data

The data are required when the system is used continuously PII. These data include instructions for editing of fascicles of pipe piece drawings to be supplied by the design department to the shop, and the names of hull blocks, pipe units, pipe treatment, pipe diameters and so on.

b. Pipe piece data

They are required when the system is used from PI and are more or less the same as those for pipe lines.

(2) Data Base

Pipe piece data are stored in PMP file, represented in a four-level list structure and accessed by DAM.

The required capacity of the file is about 9 MB/ship.

(3) Output

The output at this stage includes, in addition to the list of input data, the following:

a. Pipe piece drawings

They contain all information, including the shape of each pipe piece, needed for fabrication of individual pipe pieces. Pipe piece drawings are obtained through the dot printer.

b. Various lists

The following lists are supplied for administrative use in the fabrication or design department:

• Indexes of pipe piece drawings

These lists, used as indexes of pipe piece drawings, are edited for each fabrication line, and also contain quantitative list of parts.

• Quantitative list of parts

This list indicates with respect to each item of part, a cumulative total for each file of pipe piece

** H ** ** S,NO-4516 ** << THE SUMMARY TABLE OF FLANGE >>
** SHEET NO, HB-C PAGE- 2

MATL	STD	TYPE	CLAS	ND	ORDER-NO	FQ	FM	FB	AG	WH	FL	YA	YT	YJ					TOTAL
VBSC		5K-FS		15		9	4	0	0	0	0	0	0	0	0	0	0	0	13
VBSC		5K-FS		40		8	2	0	0	0	0	0	0	0	0	0	0	0	10
SS41		5K-FS		15		0	0	3	0	0	0	0	0	0	0	0	0	0	3
SS41		5K-FS		25		0	0	0	0	0	7	16	0	0	0	0	0	0	23
SS41		5K-FS		40		0	0	6	0	0	8	5	0	0	0	0	0	0	19
SS41		5K-FS		50		0	0	0	0	0	0	47	0	0	0	0	0	0	47
SS41		5K-FS		65		0	0	0	0	0	0	3	0	0	0	0	0	0	3
SS41		5K-FS		80		0	0	0	0	0	0	0	0	2	0	0	0	0	2
SS41		5K-FS		100		0	0	0	0	0	0	0	14	0	0	0	0	0	14
SS41		10K-FS		15		0	0	0	4	0	0	0	0	0	0	0	0	0	4
SS41		10K-FS		50		0	0	0	4	0	0	0	0	0	0	0	0	0	4
SS41		10K-FS		65		0	0	0	0	1	0	0	0	0	0	0	0	0	1
SS41		10K-FS		65		0	0	0	2	0	0	0	0	0	0	0	0	0	2
SS41		10K-FS		80		0	0	0	0	9	0	0	0	0	0	0	0	0	9
SS41		10K-FS		100		0	0	0	0	3	0	0	0	0	0	0	0	0	3

Fig. 12. Quantitative List of Parts (Pipe)

drawings, or for a whole ship, at any desired time.

Quantitative lists of heat insulation materials(Fig. 12)

The required quantities of heat insulation materials are indicated in the same manner as the quantitative lists of parts.

c. NC pipe fabrication information

NC pipe fabrication information, including data for cutting, welding and bending in the pipe shop, is generated.

4. Principal Functions

HICAS-P exerts elaborate and diverse functions in all aspects of input, internal processing and output, since it incorporates careful measures for procedures and methods used during differentstages of pipe work from design to installation. Typical functions of these are:

4.1 Optimum Route Calculation Function

In the optimum route calculation the pipe passage data and the data for the pipeline terminals are used, as memtioned above.

(1) The pipe passage data

The location, the dimensions, the mutual relations of the pipe passages.

(2) The data for the pipeline terminals

The location of terminals, the diameter of pipelines, the name of pipe material list, the assignment of the pipe passage necessary to pass or necessary to avoid.

Tak ing in these data, the pipe route is calculated basing on the following functions.

(a) To select the shortest possible route.

(b) To adjust the length of a pipe by certain correction every time it passes through bent passage.

(c) To select a route that does not pass the specified point.

(d) To select a route that definitely passes the specified point.

(e) To calculate whether the sectional area of pipes exceeds the permissible limit of the relevent passage. If exceeded, the passage will not be utilized any more.

(f) To process in order of diameter, pipe of larger

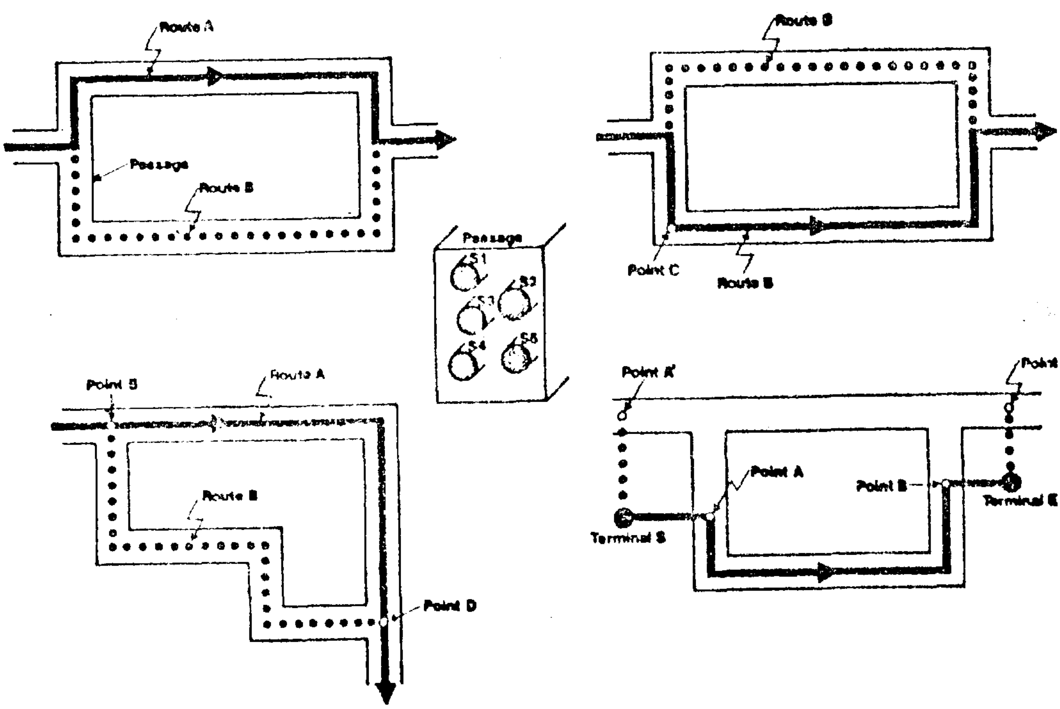

Fig. 13. Optimum Route Calculation

diameter is given a higher preference in principle.

(g) To determine the branch point automacally by specifying only branch terminal and name of the main pipeline.

(h) To determine automatically which passage should be selected when terminal points are outside the passage.

Pipelines are kept apart one another by a certain interval on the drawing for verification or examination.

4.2 Automatic Pipe Arrangement

This calculation proceeds basing on data for the pipe passages and for the optimum routes after they are determined.

The process of this calculation is to determine concretely the relative position of the pipelines, and at present, the program which has the following functions is under development.

(1) The pipes will be arranged on the level as far as possible so that the pipe bands and supporters can be easily fitted.

(2) Pipes are so arranged that they would not be interfered one another, for example, the down going pipe is arranged at lower level than up-going one.

(3) The pipes to be kept away from each other are arranged apart as far as possible.

(4) The pipes to be arranged outside the passage due to installation or maintenance are arranged so as far as possible.

4.3 Interference Check Function

This does not have to function if the pipe route data generated by the aforesaid "Automatic Pipe Arrangement Function" are available.

Manually input data are mainly checked here.

There are three major factors as follows.

(1) Interference between pipes.

(2) Interference between pipes, machines and equipment.

The machines or equipment are substituded by cuboids, cylinders or their combination.

(3) Interference between the pipes and the hull structures.

When an interference is detected, the position, depth and others. In this process, the efficiency of CPU run time is deliveratelý considered.

4.4 Combination with Hull Design System

HICAS-P can be operated in conjunction with a hull design system according to the procedures shown in Fig. 15.

In case of combining with your hull design system the mediate programs between them may be developed upon the technical negotiation.

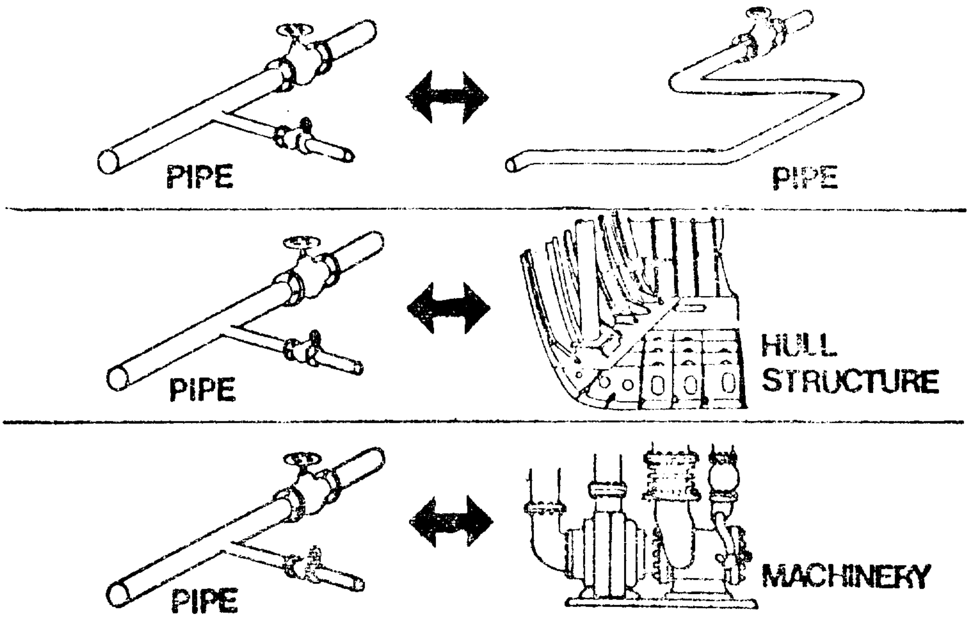

Fig. 14. Interference Check Function

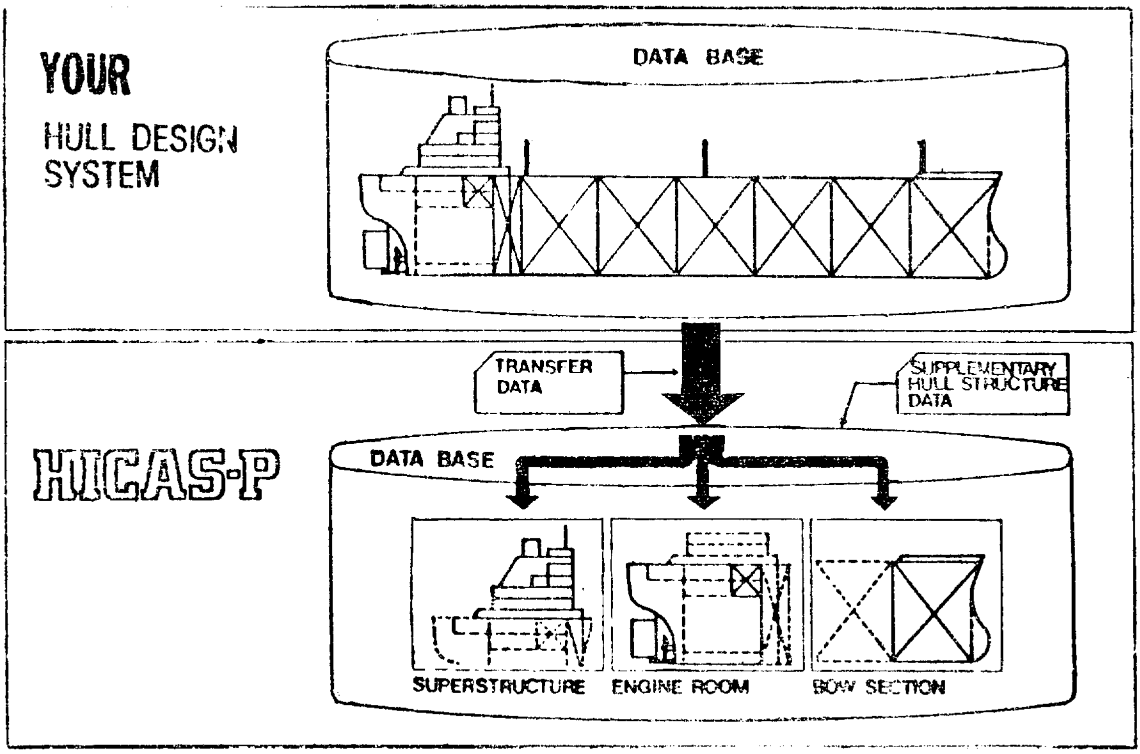

Fig. 15. Combination with Hull Design System

The following functions are provided when combined.

(1) HICAS-P can use most of data generated by the hull system.

Generally, the data such as frame lines, water lines, position and scantling of longitudinals, etc. are due to be transferred to HICAS-P

(2) Necessary data, such as super-structures, pillars, walls, divisions for pipework and so on,which are not included in hull design system can simply be stored manually.

(3) Even if any hull system is not available, HICAS-P would be capable of receiving rough and/or accurate hull data.

4.5 Automatic joint Positioning Function

The Fundamental logic of automatic joint positioning consists in principle of "minimigation of joints" with an eye to efficient utilization of materials and simplification of fabrication and instrallation of pipes. In other words, it is a method to break down pipellines into the longest permissible pipe pieces under givne conditions. With the addition of the following seven functions to this basic principle, HICAS-P automatically achieves joint positioning:

a. Automatic allomtent of adjusting pipes between hull block.

b. Automatic allotment of reducers and other choking devices for the pipes of different diameter.

c. Automatic assignment of piece names;

d. Automatic break down of pipes where successive bending is impossible;

e. Abstention from positioning of joints where pipe crosses certain specified of hull structure;

f. If specified, allotment of pipe pieces of multiple unit lengths

g. Allotment of pipes to be bend by a pipe bender in such a manner that the flange can be fitted in advance as far as possible.

Joint positioning is accomplished referring to various pre-set limiting conditions such as the size of plating bath, length limit on lining treatment, etc., which can be altered as desired. Above all the follo-

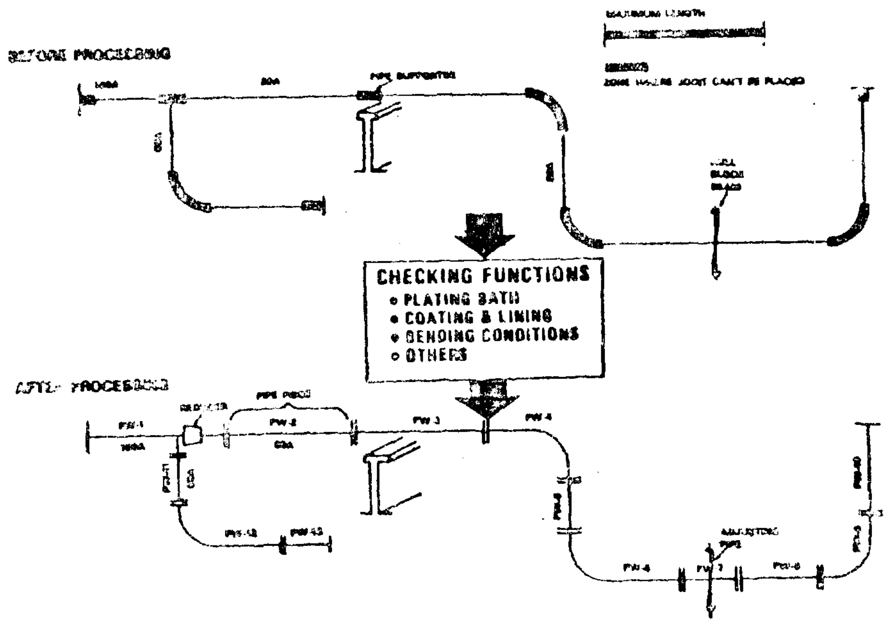

Fig. 16. Automic Joint Positioning

wing three limits, the fundamentals to joint positioning, can be varied whenever desired:

a. Maximum length of pipe piece

b. Maximum number of bends per pipe piece.

c. Type of joint to be inserted

4.6 Automic Drafting Function

The designer can freely determine the following factors:

a. The direction in which the object to be drafted should be viewed can be freely selected. Plan, profile, cross-sectional or isometric drawings are obtained according to the direction of view he chooses.

b. The drafting area can be freely selected.

The upper and lower limits of the drafting area are decided in terms of hull structure components and displacements therefrom.

c. The objects to be drafted can be freely selected. Pipeline and hull structure components can befreely selected for or excluded from the objects.

d. Pipelines can be drafted in either single or triple lines. Single and triple lines can be used in combination, changed over from one to the other at a diameter selected by the designer.

e. Relative positions of pipes can be clearly indicated by the elimination of the hidden line.

f. The type of line(solid, broken or chain) or of drafting pen can be freely selected.

g. Drafting sequence can be freely selected.

h. Plural figures can be arranged on a sheet.

i. The scale of reduction can be freely selected.

j. Graphic symbols of fittings can be parametrically expressed.

k. Complete instructions to the operator of the drafter can be supplied.

l. The relative position of each pipeline from base hull structure can be indicated with numerals and dimension lines.

4.7 Pipe Piece Drawing Supply Function

Pipe piece drawings supplied by HICAS-P contain useful information which is not given in manually prepared drawings. Such information includes the following:

a. Accurate lengths of pipe materials

Calculations are carried out taking account of allowances for welding flanges, accurate dimensions of bends, allowances for elongation due to bending, difference of length between raw and wrought material which results from margin for cutting and/or bending.

b. Set length, angle of bend(with due allowance for spring-back) and bending sequence in bending with a pipe bender.

c. Angle of deviation when a flange is fitted at an abnormal angle.

d. Finished weight of pipe.

The following considerations are taken into account with a view to apposite representation of the shape of pipe pieces:

a. The scale of reduction is automatically determined according to size.

b. While the shape of pipe is, in principle, represented in double-aspect projections of first angle, one of five different modes of representation including single-aspect figure is automafically selected according to the shape.

4.8 Pipeline Definition Function

a. To facilitate entry of information on pipelines, which are ultimately represented in coordinates, rpresentation is made possible in the following ways:

- Coordinates of each point can be freely selected from the following:
  - Displacements from hull structure components
  - Increments from the immediately preceding point
  - Displacement lengths
- The above coordinates can be given either by the center line or the outside surface of pipe. Where coordinates concern a part of certain breadth, they can begiven by the center or either end of the part.

b. When the object of input is a part which differs from those in the material list, the name of the part can be defined in any desired way.

c. While pipeline data are as a rule defined sequentially along each pipeline, it is possible to add new points to already defined pipelines.

5. Direct Entry System From Drawings

The PF system is intended to enter the required data for hull structure, pipelines and pipe pieces into the PC system using the front-end computer system with its peripheral units arranged beside the designer. It can help replace the data entry in data sheets with the simpler work of direct feeding of information from drawings, and thereby reduces substantially input load.

5.1 Composition of Hardware

The hardware of the PF system consists of the units shown in Fig. 17 each of which functions as follows.

(1) Digitizer

This device allows entry of almost any data from a drawing laid on a board. A menu is used for entry of data other than coordinates.

(2) Graphic Display

It is used to display entered data in letters or graphic figures for verification and operation guide.

(3) Function Keyboard

It is used to indicate the preset functions for input operation.

(4) Magnetic Tape

It is used for storage of input data and transferred to the PC system when data pick-upis finished.

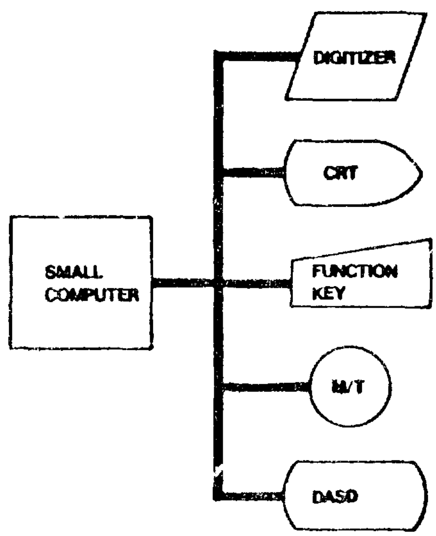

Fig. 17. PF Hard ware Configuration

5.2. Entry Procedures

Data entry in to the PF system is accomplished as mentioned below.

(1) Preparatory Steps

a. The drawing to be read is placed on the board of the digitizer.

b. The menu is placed on the board of the digitizer.

c. The states of the drawing and menu placed on the board are transmitted to the computer.

d. The origin of coordinates and the scale of reduction are entered.

(2) Entry of Hull Structure Data

Since data for hull structure are classified in advance into a number of categories, and the system makes inquiries in the pre-set order of the categories, the designer therefore enters in that order the hull structure data using the digitizer.

(3) Entry of Pipeline Data

a. Entry is accomplished point by point along each pipeline.

b. The data entered are displayed on the screen unless the designer erases them consciously.

c. Pipelines already entered can be shown on the screen of the graphic display for check-up by using function key.

(4) Clearance

The magnetic tape on which the data are stored is dismounted and the entry procedures are brought to a finish,

5.3 Features of The System

The PF system is characterized by the following features:

(1) The PC system requires no punched cards. Input data are directly registered on magnetic tape and the system operating cost is saved correspondingly.

(2) Early detection of input errors is possible.Since any input error is instantly made known by either figures on the screen or the buzzer, it is detected much earlier than it would be in a conventional data sheet system.

(3) Entry operation is easy. Since the basic principles of input procedure are incorporated in the program and the data to beentered are indicated successively on the screen of the graphic display, little skill is needed.

(4) Data preparation is accomplished with less input load, about half of that required by the conventional data sheet process.