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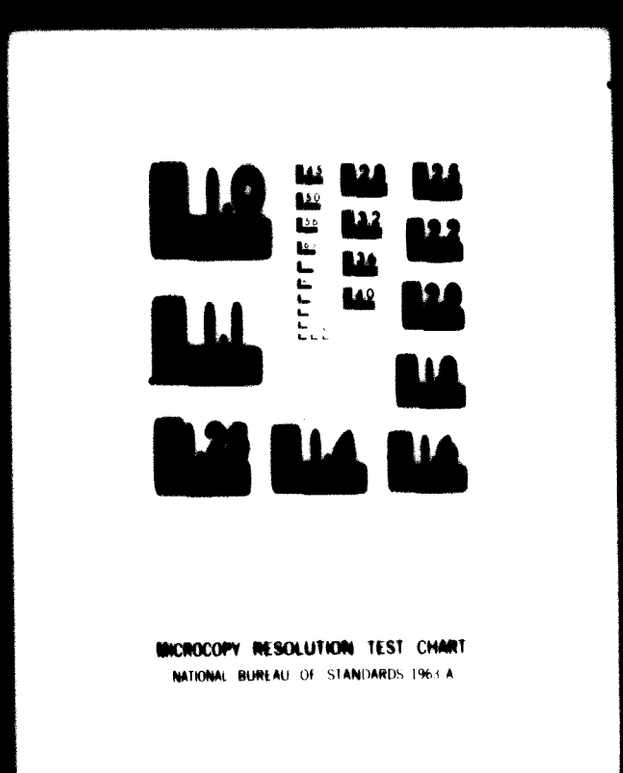

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U N I D O

Assistance to the
Yugoslav Governmental Enterprise METALNA
on material handling equipment

FINAL REPORT

F·H·KOCKS K·G

KOCKS INGENIEURE

CONSULTING ENGINEERS ENGINEERING CONSULTANTS INGENIEURS-CONSEILS مكتب هندسي

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

Attention: Chief, Technical Equipment
Procurement and Contracting Office

Lerchenfeldstrasse No. 1

A-1070 Vienna/ A u s t r i a

Duesseldorf, 18 December, 1970
Ki-ka/mi - 287

Subject: Assistance to the Yugoslav Governmental Enterprise METALNA on material handling equipment, Ref. SIS 70/829, Contract No. 70/58

Dear Sirs,

Following your acceptance of our draft final report with your letter dated December 1, 1970 we transmit the Final Report in 20 copies.

Yours very faithfully,

F. H. KOCKS KG
Consulting Engineers

B.P. Giesler
General Manager

United Nations Industrial Development Organization

Assistance to the Yugoslav Governmental Enterprise

M E T A L N A , Maribor

on

MATERIAL HANDLING EQUIPMENT

Final Report

P. H. [redacted] KG, Consulting Engineers, Duesseldorf

Expert: KURT PEBOCK, Brinkum-Bremen

Duesseldorf Dec. 15, 1970

SUMMARY

The report on material handling equipment of the Yugoslav Government Enterprise METALNA shows on the basis of the range of production of METALNA the present general situation of material handling. Development trends have been indicated and evaluated.

It has been emphasized that conservative crane constructions will sell poorly soon and new the reasons of which have been stated.

Material flow and accordingly automated systems are determining the future situation in industry, harbours, and in trading companies. Manufacturers of material handling equipment have to apprehend this situation and to adjust their programme accordingly.

Final particular recommendations have been made and further assistance to METALNA proposed.

[redacted]

TABLE OF CONTENTS

PART I

1. Introduction

On request from the Government of Yugoslavia the services of a consulting engineering company have been required to advise the Governmental Enterprise METALNA, Maribor, Yugoslavia on development trends in material handling equipment.

UNIDO engaged the services of F. H. Roche KG, Consulting Engineers, Duesseldorf, Federal Republic of Germany. On September 25, 1970 an appropriate contract was entered into between UNIDO and F. H. Roche KG.

To perform the required services the consultant's expert studied and analysed the local situation by means of 2 visits to METALNA with a duration of one week each. His findings, the appropriate evaluations and recommendations are submitted with this report.

PART I

Present situation of MITSUBISHI

[redacted]

[redacted]

Figure 1 [redacted]

3.01 Total range of production

The range of [redacted]'s production program is wide. The various branches are listed as follows:

a) Steel buildings
b) Steel bridges
c) Crane construction, other handling and conveying equipment
d) Steel hydraulic structures (sluice gates and other facilities)
e) Ship's hatch covers
f) Cooling systems
g) Water pressure lines
h) Expansys
i) Rotary tables (machines) for grey cast iron
j) Appliances for chemical industry and steel works
k) Equipment for agricultural plant protection

Production of material handling equipment is about 3o % of the total turnover which amounts to approximately US $ 23 million. According to the tasks assigned by UNIDO investigations and evaluations as shown in this report are limited to material handling equipment and expansys.

3.02 Production of material handling equipment

This branch of production includes besides material handling equipment such as cranes also up to a certain extent conveyors. The program consists of the following types:

1) Overhead travelling cranes
2) Loading bridges
3) Slewing (rotary) cranes (harbour, yard, wharf, and ship yard cranes)
4) Portal cranes
5) Shipboard cranes
6) Mobile and truck cranes
7) Bunker cranes

8) Cranes for steel hydraulic structures (sluice gates)

9) Rotary tower cranes for building construction

10) Truck mounted cranes

11) Ropeways

Some of the crane types have been built for years, others were included in the program only recently in order to meet the requirements of the market. Annex 3 shows a list of cranes and other equipment built up to now by METALNA.

2.03 Analysis of the production of material handling equipment

The program covers a wide range of crane constructions, the general significance of which will be shown.

2.03.01 Overhead travelling cranes, by far the most numerous type of all crane constructions. Only until a short time ago, there was no other equipment as efficient for material handling in halls and storage yards. But nowadays - due to advanced methods of mechanization and automatization of internal transport there is a large number of more feasible equipment (such as fork-lift trucks), in most cases with much lower investment costs.

Only as a low priced standard crane the overhead travelling crane in future will be competitive to some extent. These types cover lifting capacities up to 20 tons according to the electric hoists and spans up to 25 m so that they still can be manufactured out of joists.

Overhead travelling cranes with large lifting capacities and spans as well as special cranes such as steel work cranes must be considered as special designs requiring higher prices.

To ensure profitableness, one has always to bear in mind these two different categories of overhead travelling cranes.

2.03.02 Loading bridges as bridge constructions with trolley carriage or slewing crane for grab and piece good handling nowadays are demanded rarely only.

All-purpose loaders like the loading bridge, likewise suitable for unloading of ships, storage yard service and reloading

have been replaced by special-purpose-loaders with only one function. This increases the efficiency and breakdowns will not affect the whole plant.

2.03.03 Slewing cranes travelling on rails for storage yards, harbours, and wharfs are of different demand but generally a recurrent trend may be noted. In storage yards, more and more fork-lift trucks and portal cranes in light tubular construction are used. In harbours, there is generally a surplus capacity of conventional piece good cranes as more and more heavy collis are used and especially the container handling has prevailed in a remarkably short time.

Heavy wharf cranes with more than 2o tons lifting capacity are expected to gain importance but their number will continue to be small. The same applies to shipyard cranes.

2.03.04 Portal cranes of light tubular construction show a favourable development. This has already led to quite a competition which however has reduced prices considerably. Only economical constructions and manufacturing methods can achieve satisfactory selling results.

Initially designed for wood depots, these cranes are always considered as a main alternative for storage yard projects and are more and more used. Some set-backs however have occurred because not enough attention was paid to a very careful welding of seams at the main supporting tubes. With leaking joints condensation water may collect in the hollow spaces of the tubes and may deform them in case of frost, endangering the whole construction.

2.03.05 Shipboard cranes the market of which is very differentiated. The determining factors are decisions of the shipping companies on routes and harbours to be called at by the ship. The decision on the installation of shipboard cranes depends on the existence of suitable equipment in these harbours. The shipping companies will always try to save the investment costs for shipboard cranes.

Calculating the prices the crane manufacturer has to take into consideration that his guarantee may turn out very expensive. In cases of damage, material and mechanics must be transported by aeroplane to other continents.

2.03.06 Mobile and truck cranes first of all require a good service and well assorted spare part stock. The service requires an adequate number of mechanics with mobile repair shops stationed

in different parts of the country to be at hand as soon as possible if necessary. Damages of mobile cranes can turn out very expensive for the owner, for instance in the course of a difficult assembly, or if closely scheduled employments cannot be met. The crane manufacturer must take these circumstances into account. As the costs for a good service are considerable an all round mobile crane program must be offered to obtain the best possible sales figures.

Mobile cranes with telescopic jibs are in great demand, especially small cranes with a lifting capacity of 6 to 8 tons and a velocity of about 7o km/h. The telescopic jibs avoid the time-consuming assembly of the jib parts, the crane is ready for operation and usually can change the length of jibs even when loaded.

Although generally the range of lifting capacities sought after is limited around 6o tons, an assortment of cranes with much higher lifting capacity often is profitable because it allows the use of bigger assembly units reducing considerably the overall cost for assembly inspite of higher cost for the cranes themselves. The lifting capacity of standard mobile cranes ranges up to 1oo tons and of special types up to 5oo tons.

2.03.07 Stacker cranes have to be considered as a unit together with the appertaining storing facilities. To make the stock keeping more efficient essential storing techniques have been developed. These techniques result from the requirements of organization. In future storing techniques will become even more important. As the crane forms part of the whole plant, the crane manufacturer too, must know the basic requirements of storing techniques.

2.03.08 Cranes for steel hydraulic structures are not subject to the highly competitive situation which applies to the other crane constructions. Safety is the main aspect of their construction. They are a logical supplement to the production program of a hydraulic engineering manufacturer.

2.03.09 Rotary tower cranes for building construction have gained a firm position in building construction. Actually big civil engineering construction projects cannot be carried out efficiently without building cranes. The market chances are good. Again, however, prices are rather low too. With the increase of multi-story buildings, the demand of climbing cranes has risen and should be considered in the program.

2.03.10 Truck mounted cranes have good chances of selling. But it must be taken into account that the price has to be low and that complaints during time of guarantee may have a great influence.

2.03.11 Ropeways have gained importance with the increase of tourism. But they require an individual approach based on the aspects of safety.

2.04 Summarizing view on METALNA's production of material handling equipment

The chances of selling of cranes, provided for in METALNA's program, have been discussed from the technical point of view and with regard to the different market situations in the preceding part. The chances range from good to fair. Decisive are the commercial results only. The continuous comparison between

turnover - total cost - profit

of each single product is necessary and only allows conclusions.

The prices of cranes mostly cannot be raised according to the cost requirements of the manufacturer because of competition. Moreover, it is necessary to improve the income of the employees The only solution is to reduce cost raising factors, i.e. to rationalise more and more.

Time of delivery is, besides the prices, of decisive importance nowadays. Often a higher price is accepted with earlier delivery. Attempts must be made to reduce the actual manufacturing periods and at the same time, to speed up the material procurement. While in other cases this mainly depends on the ability of the purchasing department, for METALNA external factors, not susceptible by the company ,are of importance, too. It cannot purchase at its free discretion the required material, if necessary abroad, but has to undertake an often wearisome administrative procedure.

PART 3

Present general situation of material handling, development trends, and evaluation.

3. Present general situation of material handling, development trends, and evaluation

3.01 General

Immense changes in material handling take place presently. The constantly increasing transport of goods requires first of all an accelerated circulation of the means of transportation. This demands very efficient material handling equipment, as the equipment used up to now is mostly too slow and still needs too much human labour.

The essentials of the problem become more clear if the variety of transportation and handling systems is not taken into consideration:

> The goods must be transported with a minimum of cost from the manufacturer to the customer. The cost arising on their way increase their price without any increase of their quality.

A few years ago everywhere in the world human labour was very cheap, technical equipment and furnishings however very expensive. Today in many parts of the world the same situation still exists in comparison with the industrial countries in which a shortage of human labour has developed resulting in a fast and large increase of wages and saleries. With the expanding of the industry the output of goods increased and the old-fashioned material handling systems had to fail one day as they were too slow and too expensive.

Following the routes and the stations of transported goods and considering how often the goods have to be "handled" one can imagine by comparing the cost between human labour and machinery that the high cost for labour had to be reduced. Even the appearance of modern piece good cranes at the wharf of a harbour should not mislead oneself as a look at the inside of a ship will show. There are many labourers working to load or unload the ship manually.

There are various approaches to change the situation. A wide variety of fork-lift trucks and conveyers is produced. In the following handling techniques will be discussed, especially new material handling systems.

3.02 Mechanized conventional piece goods handling

A few years ago the crane was the only technical device in the conventional piece goods handling. All other operations had to

be carried out by human labour. This situation has changed when the real mechanisation of the port handling started with the use of the fork-lift trucks some 15 years ago. If the fork-lift trucks can be used only on shore (figure 2) the loading inside the ship has to be done by hand as before.

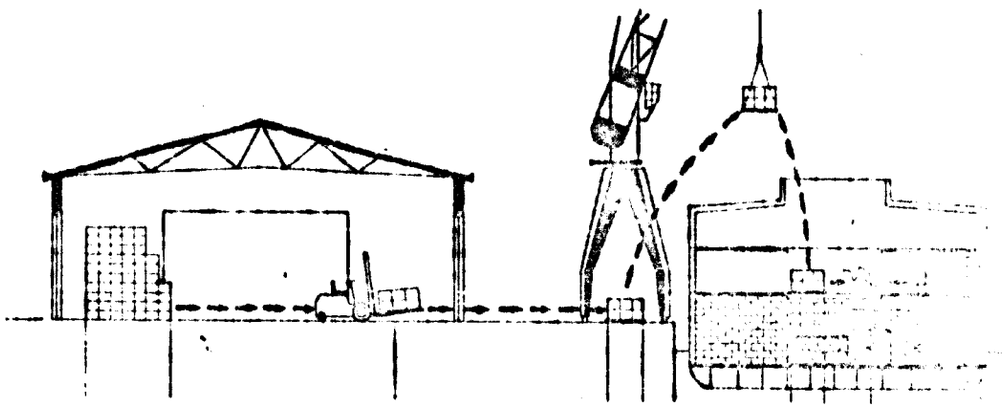


figure 2

Furthermore, the harbour pallets have to be unloaded again. With the development of suitable fork-lift trucks it was possible to use them in the ships. These trucks must be designed extremely low, have pneumatic tires, and must be designed for easy dismantling in parts to be lifted by the harbour cranes (mostly 3 tons). Additionally they must be built according to the more stringent fire and explosives safety regulations.
The use of fork-lift trucks requires large traffic areas in one level. Ramps should not exist, they would disturb the handling and would cause accidents. The new layout of such a harbour is shown in figures 3 and 4, the "NeustÄdter Hafen" in Bremen/Fed. Rep. of Germany.

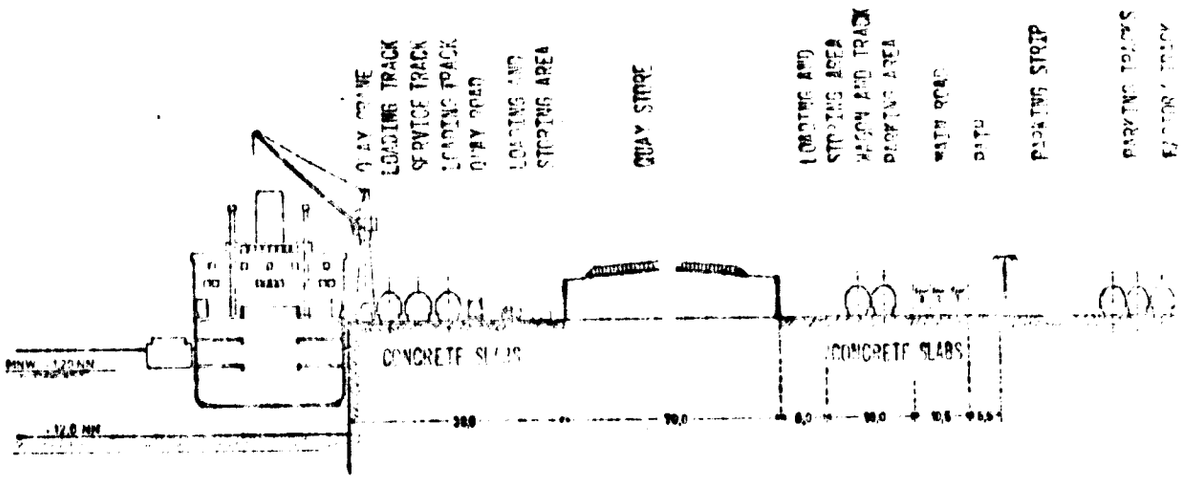


figure 3

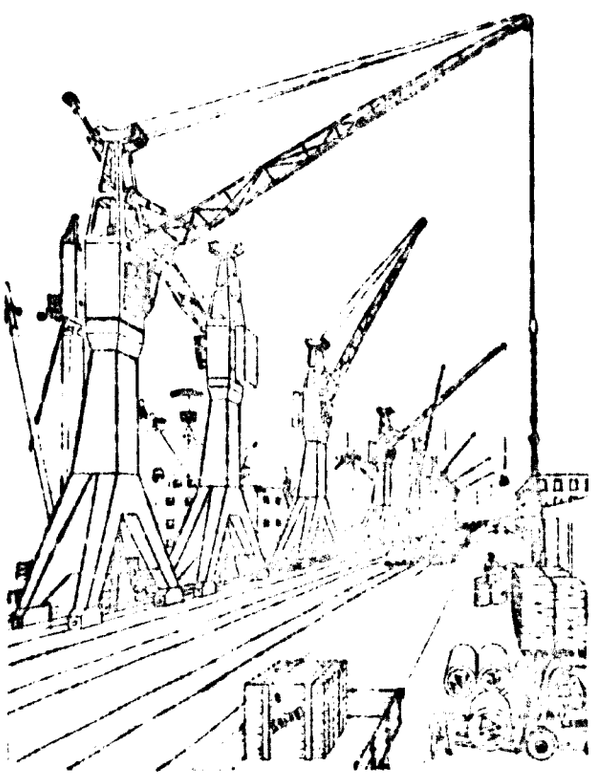


figure 4

Although facilities of this kind are designed correspondingly to the most advanced techniques they are not contenting from the economical side of view. Handwork such as stowing in the ships or in the storehouses are still used too often. The

following example will show the efficency of such equipment:

Capacity of the crane	3.0 tons
Average weight of one trip	1.5 tons
Average number of cycles per hour (of one crane)	= 17 cyc/hr
Average hourly capacity of the crane	1.5 x 17 = 25 tons/hr

With an estimated maximum of 4 cranes per ship the loading or unloading performance results to:

4 x 25 = 100 tons/hr

According to this at least 50 hours are necessary to load or unload a cargo of about 5,000 tons

3.03 Pallets

The pallet is a support in most cases made of wood, on which all the goods to be transported are stacked to a so called "transport unit". The pallet was developed through the use of the fork-lift truck. It guarantees not only an easy and safe transport but also a proper storing. With the pallet the "continous transportation chain" began in which the transport unit is the working, storing and shipping unit at the same time.
Only one of the big varieties of pallets is described here more detailed. It is the "Pool flat-pallet" 800 x 1200 mm (see figure 5)

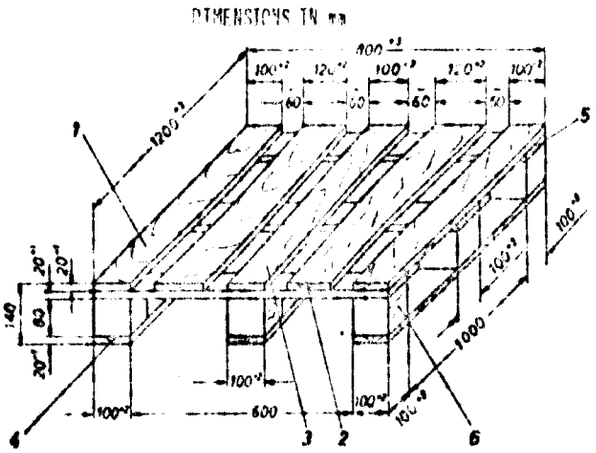


figure 5

The europeam pallet-pool, in which railroad companies of many countries are members, by stringent quality specifications made it possible to exchange the pallets freely. The return-freight of the empty pallets is not any more necessary. The weight of the pallets is not taken into account with regard to the freight rates. The transporter makes available the pool-pallet for the time of transportation. If the goods are crossing the frontier the railroad company of the receiving country places the same number of pallets it has received at the disposal of the dispatching country.

Although this arrangement is very favourable, a cheap oneway pallet would generally be preferred.Because the pool pallet is not equally suitable for all goods, the dimensions are not always the best and in shipments outside of Europe the pool regulations are not matched. Often special regulations are agreed upon or one-way pallets are used, too. In many cases - for instance in harbours - the goods are reloaded from the arriving pallet to a harbour pallet and from the harbour pallet into the ship.

The packing industry has standardised the basic packing dimension 600 x 400 mm. This dimension enables use of the pool-pallet 800 x 1200 as well as that of the often used pallet 1000 x 1200 mm.

The pool-pallet has a carrying capacity of 1000 kp, piled up it can carry 4000 kp. It is a so called four-way pallet, i.e. it may be picked up by a fork-lift truck from either one of the four sides. The pallet is of main importance in the interdepartmental transport(e.g. of a factory) and in the inland traffic. (see figures 6, 7, 8)

For sea transport a suitable stowing is necessary. Therefore the use only of fork-lift trucks under deck is not possible. Even if the pallet has not to be unloaded, the goods must be stowed away and tied with care by additional people. These are the main reasons why "containers" have been developed which can receive the goods - whether on pallets or not - and represent completely secured weather-proof closed units.

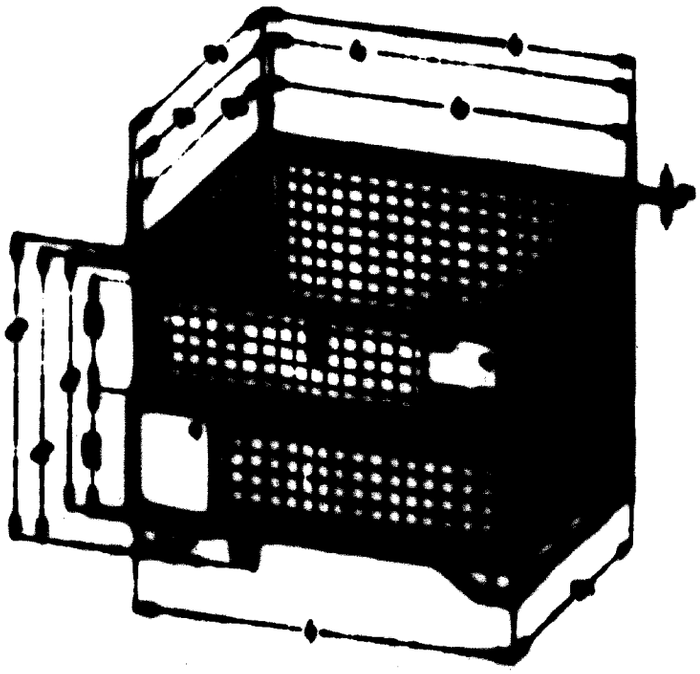
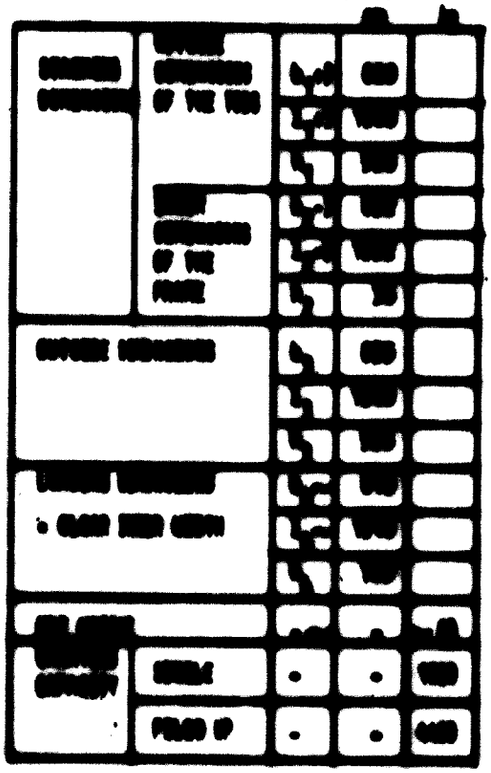


Figure 6



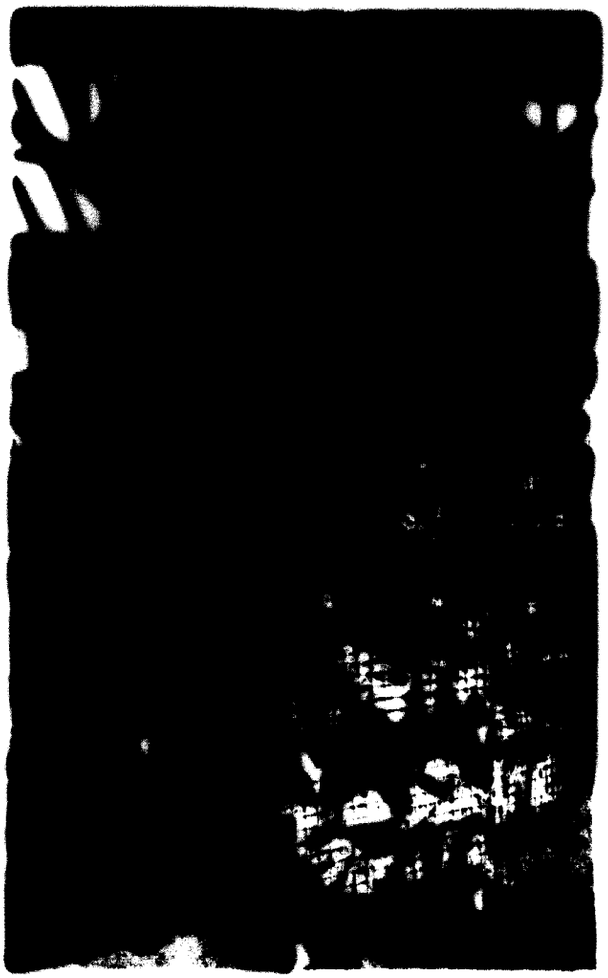


Figure 7

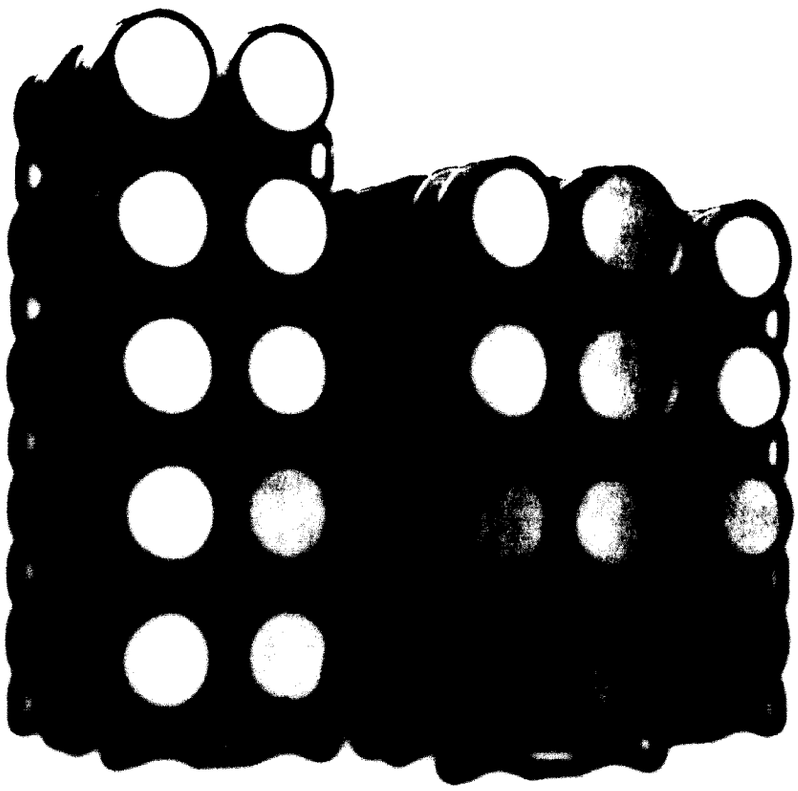


Figure 8

3.06 [illegible]

3.06.1 [illegible]

[illegible] pallets and small containers are used not only as transport units but mainly for the interdepartmental transport as handling and storing units, containers - as superposing units - are mainly provided for as transport units. The containers not only allows a fast change from one transportation system to the other (road, railroad, ship) but also makes possible the combining to big units of similar size, hence enabling rationalized and economical transport and handling. In the overseas shipping the savings are up to 30 and 35 % compared with the conventional way of transport.

Furthermore, the container is preferred because the goods can be loaded and the container closed already in the manufacturing plant and will arrive at the customer without reloading in their unbreakable and weatherproof container.

The container sizes, standardized by ISO and the permissible gross weights are compiled in figure 9. Because containers are used in the USA since some 10 years - in quite large number - their dimensions had to be taken into consideration. Dimensions of the cross section (8 ft x 8 ft) are based on the US traffic law, which allows a maximum width of vehicles of 8 ft = 2435 mm. The height results from the height of the coiler plate of semitrailers on one side and the clear height of the roadbridges on the other.

No.	Type of container	Skeleton sketch	Dimensions: Length mm	Length ft	Length in	Width mm	Width ft	Width in	Max. permissible gross weight t
1	1A	12192 mm – 40'	2435	8	–	2435	8	–	30
2	1B	9125 mm – 29'11.25"	2435	8	–	2435	8	–	25
3	1C	6058 mm – 19'10.5"	2435	8	–	2435	8	–	20
4	1D	2991 mm – 9'9.75"	2435	8	–	2435	8	–	10
5	1E	1925 mm – 6'3.5"	2435	8	–	2435	8	–	7
6	1F	1859 mm – 6'0.5"	2435	8	–	2435	8	–	5
7	2A	2920 mm – 9'7"	2438	8	0.4	2438	8	0.4	7
8	2B	2920 mm – 9'7"	2438	8	0.4	2438	8	0.4	7
9	2C	2920 mm – 9'7"	2438	8	0.4	2438	8	0.4	7

Dimensions for ISO-Containers – Container sizes of ISO standard series – Dimensions de conteneurs appartenant à la série standard ISO

Figure 9

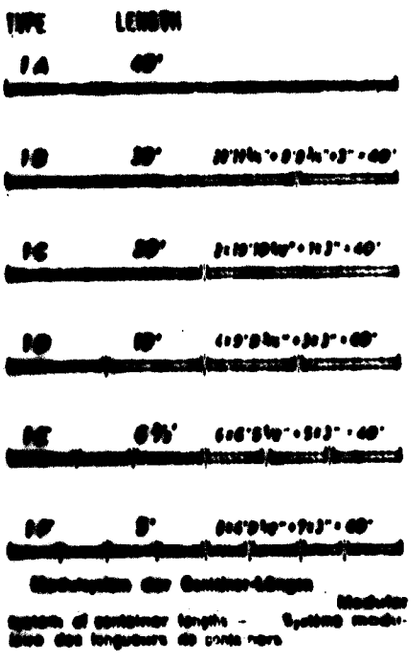
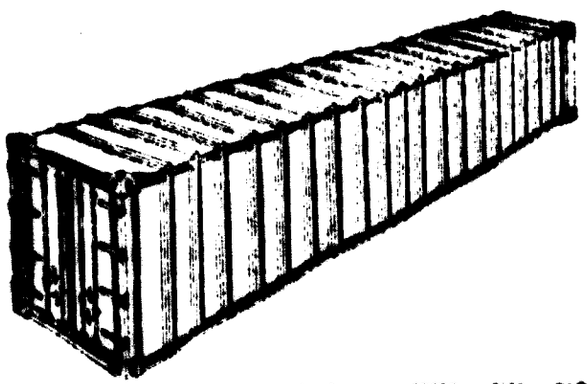


Figure 10

The lengths of the containers are chosen such, that besides a varying capacity offered also a combination with the next longer type is possible, as shown in figure 10. Containers mostly used are types "1 C" (20 ft) and "1 A" (40 ft). Figure 11 shows a "1 A" - type container.



DIMENSION	OUTSIDE (mm)	12190 x 2435 x 2435	
DIMENSION	INSIDE (mm)	11850 x 2337 x 2230	figure 11
VOLUME	(m^3)	62.6	
NET WEIGHT	(kg)	2680	
GROSS WEIGHT	(kg)	30480	
OPENING		2142 x 2250	

TECHNICAL DATA OF A 40' CONTAINER

The large pallets or so called "flats" must be mentioned also, which usually are of the same size as the container 1 C, 2435 x 6055 mm. The height however is only half or even lower. They are open loading racks with sides often hinged and to be folded. These flats are used especially for the shipment of long goods and provide a better use of the volume because of the relative low gross weight. The loading of the containers with goods on pallets caused some difficulties.

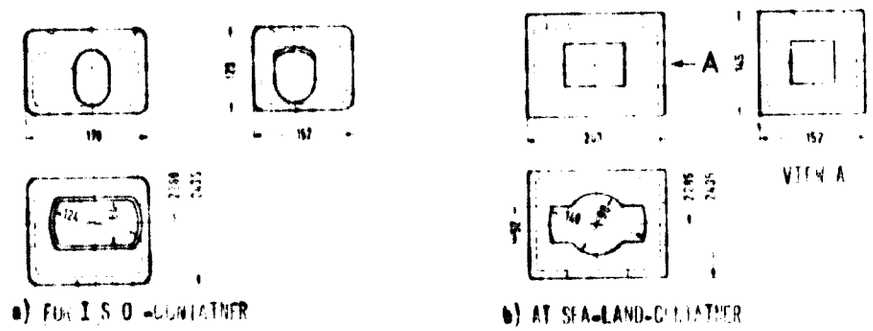
The flat pallets standardized in the year 1961 have dimensions of 800 x 1200 or 1000 x 1200 mm. The ISO container, standardized 1968 with outside dimensions of 8 ft = 2435 mm has clear inside sizes between 2150 and 2300 mm according to the insulation. This makes clear that the volume of the container is not only used poorly but that also measures have to be taken to avoid moving and damaging of the load. To eliminate this handicap it was proposed to introduce a new pallet with the size of 900 x 1100 mm. This will fail because of the far advanced storing technique with highly complicated storing facilities and the now used standard dimension of 600 x 400 mm in the packing industry.

It has been tried to build containers with different sizes in a "second generation". But this idea will fail, too, because of the high costs and necessary changes of laws in individual countries. To meet this handicap the German railway officials have built an inland-container with outside dimensions of 2500 mm (according to the German traffic regulations) and an inside clear width of at least 2440 mm. Loads on pallets can be stored very well in such a container.

Notwithstanding all difficulties which result mainly from the high cost of investment the container is a nearly ideal solution to homogenize the heterogeneous piece goods. It is the basis of an economical transport.

3.04.2 Fixing places and fixing equipment

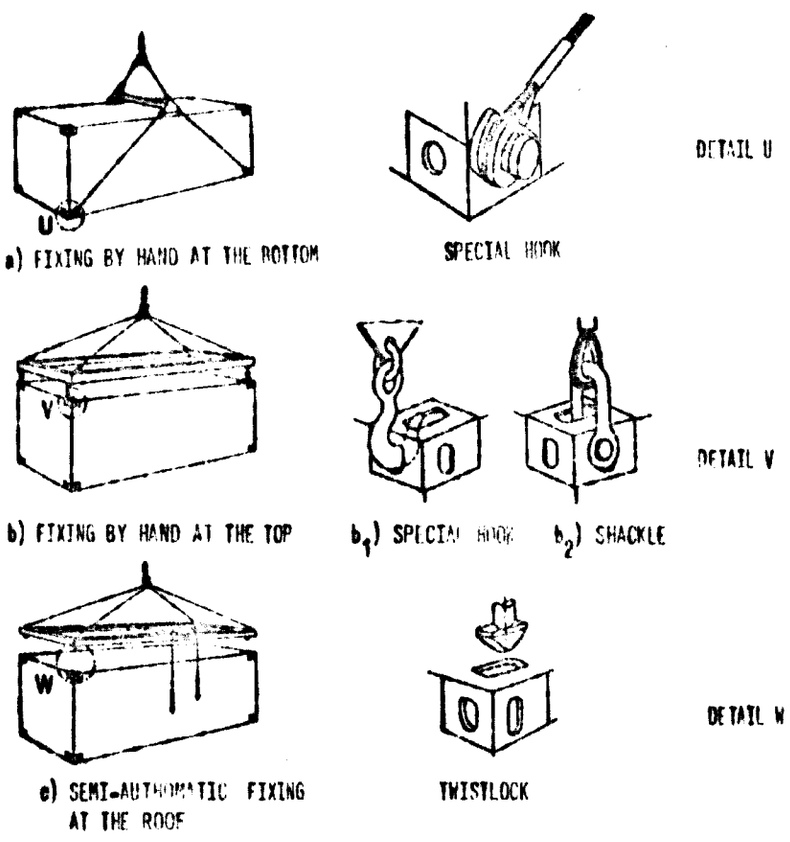
To handle the containers they are equipped with standardized corner plates (figure 12) which allow to use the various fixing tools of the handling equipment (see figure 13 and 14).



a) FOR I S O -CONTAINER

b) AT SEA-LAND-CONTAINER

figure 12



a) FIXING BY HAND AT THE BOTTOM

SPECIAL HOOK

DETAIL U

b) FIXING BY HAND AT THE TOP

b_1) SPECIAL HOOK

b_2) SHACKLE

DETAIL V

c) SEMI-AUTOMATIC FIXING AT THE ROOF

TWISTLOCK

DETAIL W

figure 13

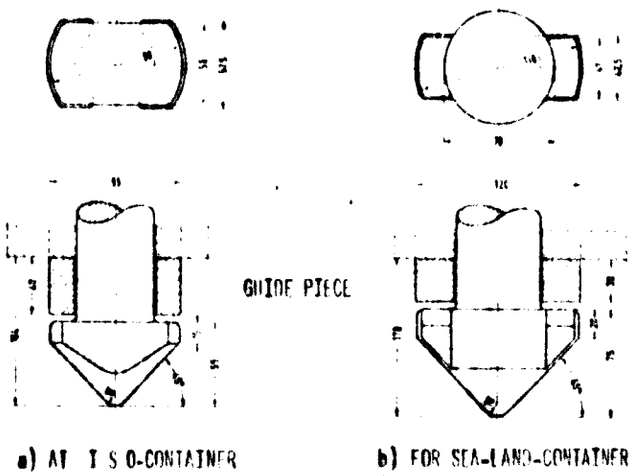


figure 14

Fixing by hand is shown in figure 13. For container bridges however so called "spreaders", electro hydraulic fixtures (see figure 15) are used with locking pins according to figure 14.

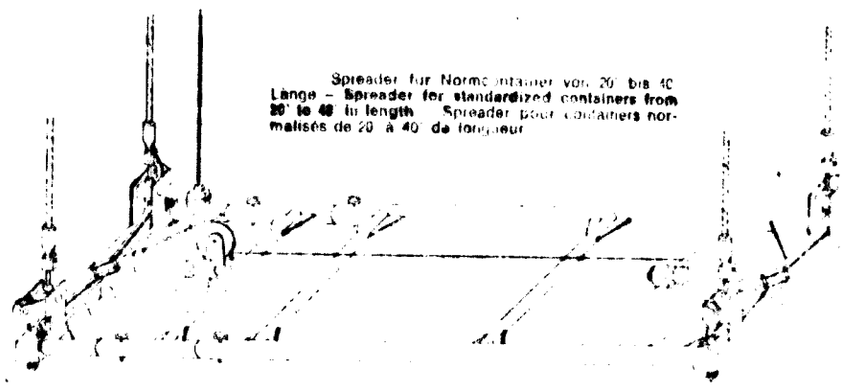


figure 15

3.04.3 Container handling equipment and systems

For loading and unloading of seagoing vessels specially designed container bridges or cranes are used (figure 16,17,18)

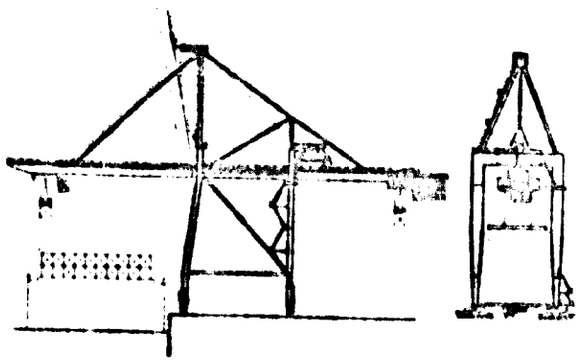


figure 16

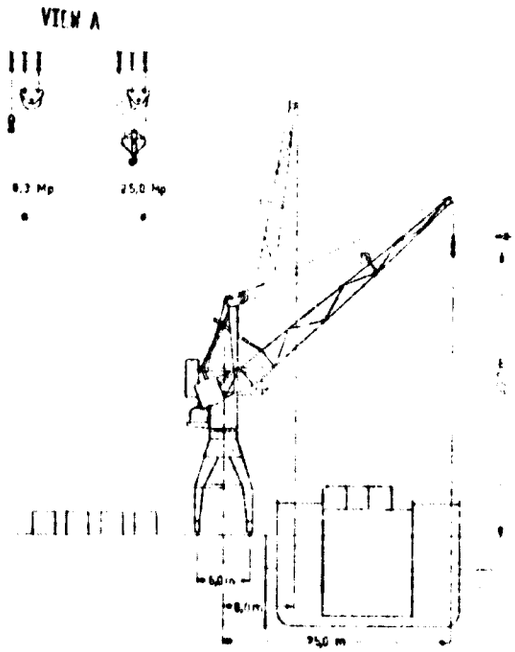


figure 17

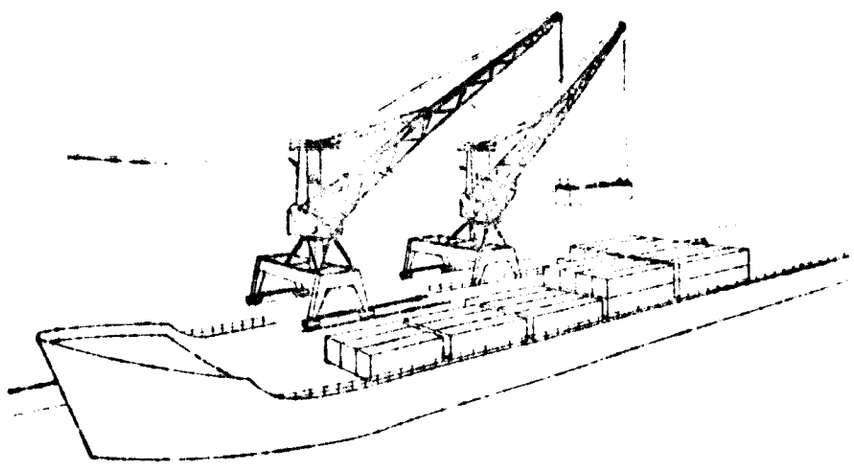


figure 18

Figure 18 shows a crane which carries 25 tons in container handling and - through changing of the hoisting-rope gear - one third of this weight in piece goods handling at triple hoisting speed.

Twin cranes to be used as twins or singles are shown in figure 19, used as twins the cranes are controlled from one crane. All the rotating and luffing movements are synchronized for both cranes.

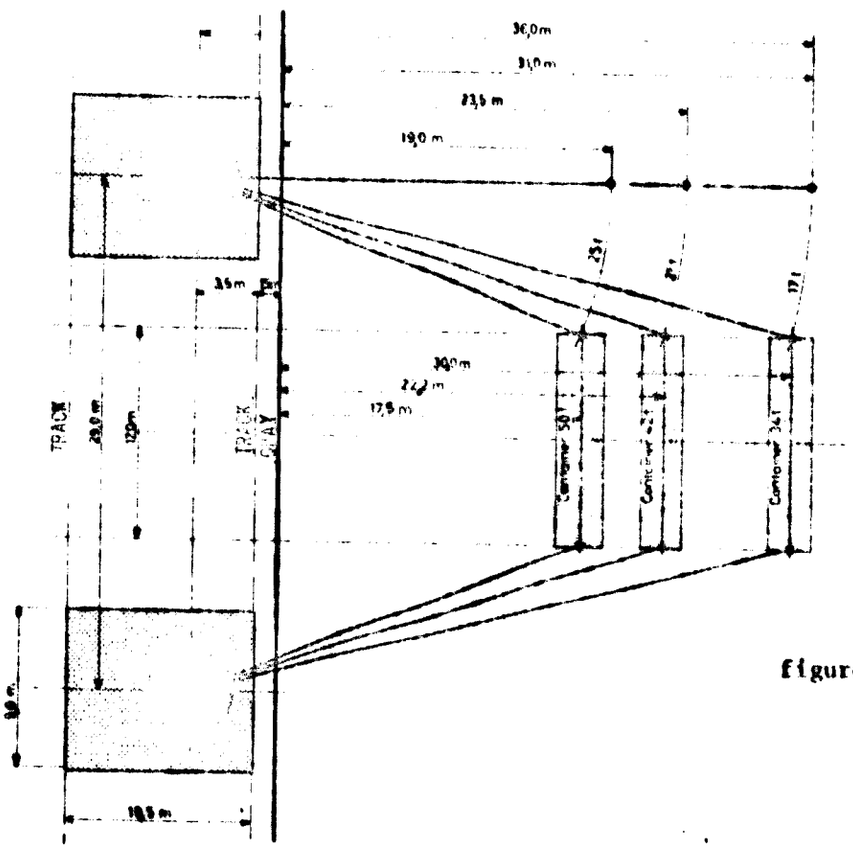


figure 19

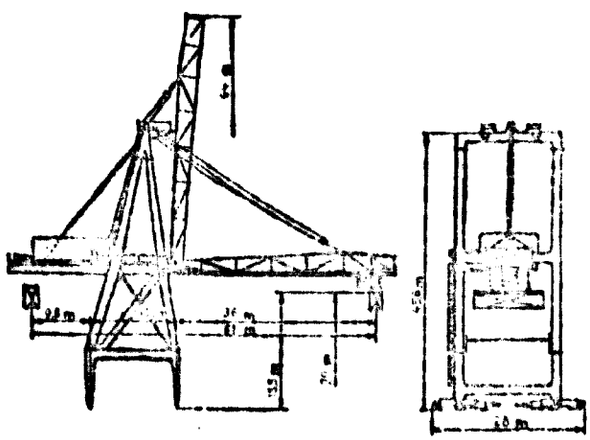


figure 20

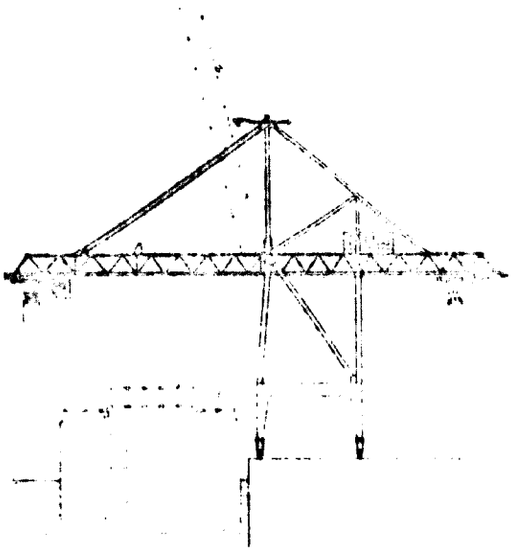


figure 21

For the bridges cranes rope trolley-carriages (figures 20 and 21) as well as fixed ones (figures 16 and 23) are used. Figure 22 shows the system of the rope-trolley-carriage of figure 21.

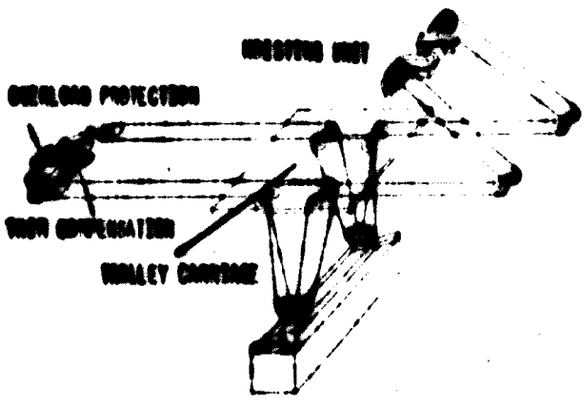


Figure 22

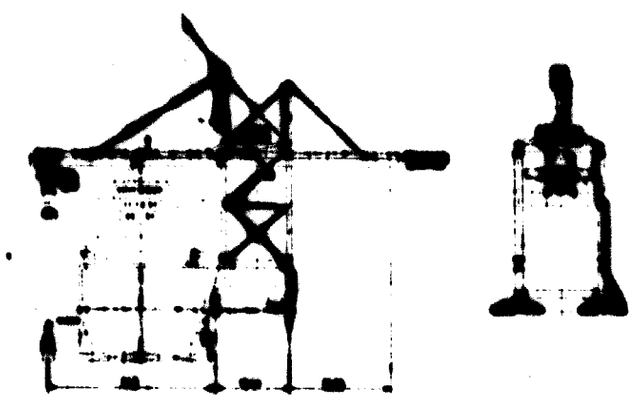


Figure 23

The hoisting units are not mounted on the trolley carriage but at the fixed part of the bridge. The trolley-carriage therefore is light and besides a low weight of the bridge also the wheel loads are smaller such influencing the construction cost of the wharf. Unfavourable however - in comparison with fixed trolley carriages is the longer hoisting rope causing a humming of the load which requires more precise handling of the crane operator.
Additionally sometimes it is required for new bridge constructions to hoist two unconnected 20 ft containers; necessitating a different hoisting device which can be placed more easily on the trolley carriage. The inland transport is carried out either by railroad or by semitrailers on special chassis. To load and unload the vehicles and the railroad cars or to serve the storing yard portal hoisting vehicles are used as shown in figures 24, 25, 26.

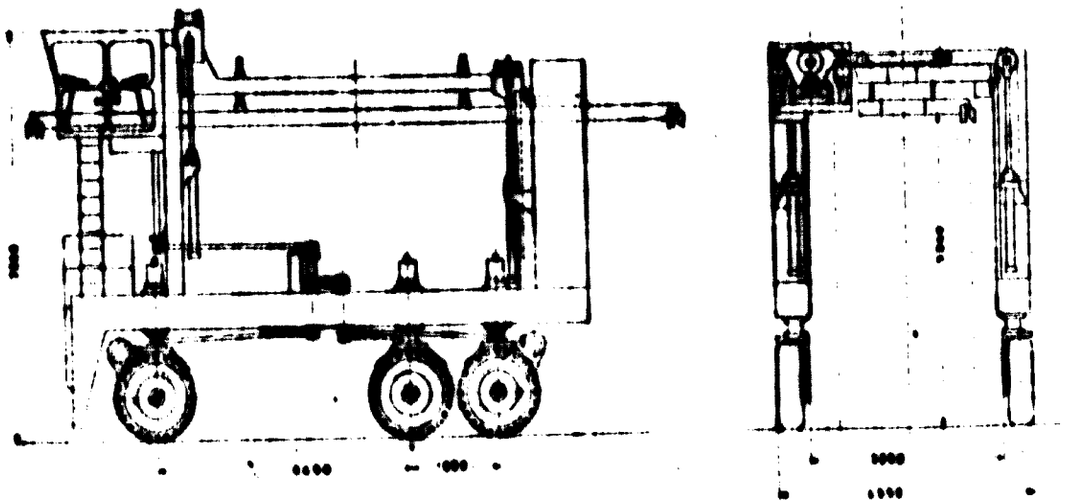


Figure 24

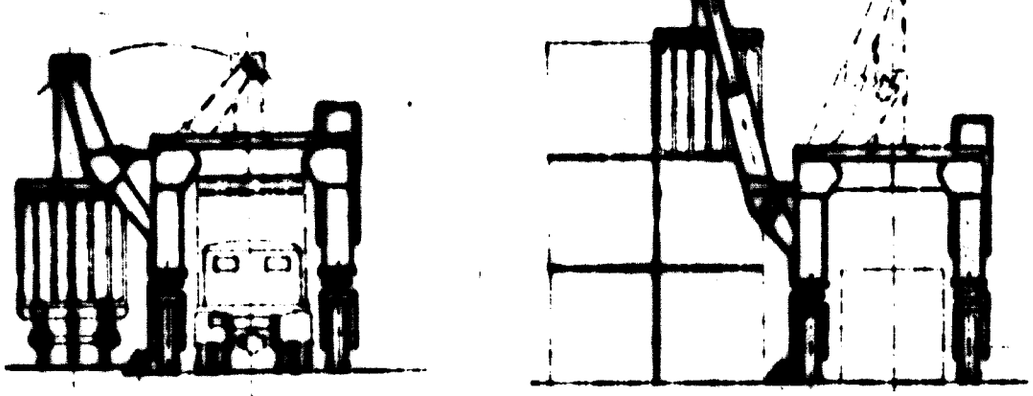


Figure 25

Figure 26

At some multiple junctions the railways of the Fed.Rep. of Germany use portal cranes to transship the containers (figure 27).

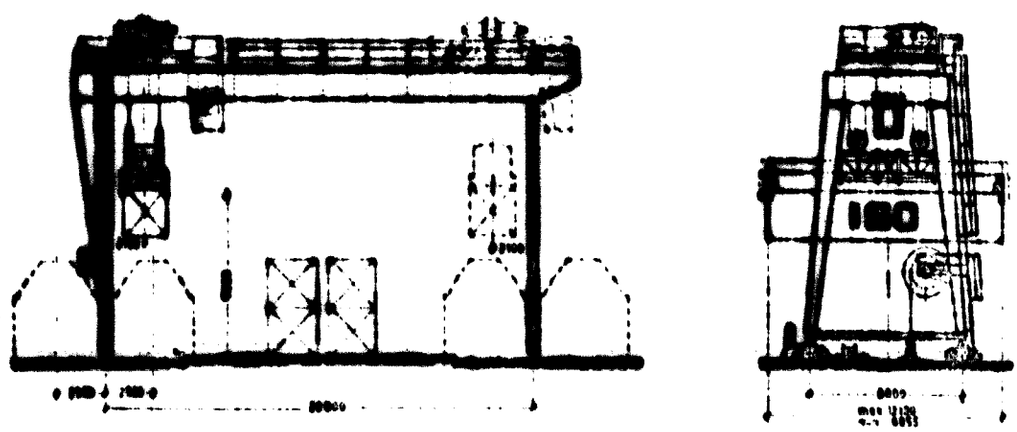


Figure 27

The containers are mainly shipped by railroad, some on rapid trains even crossing the frontiers. The transport by means of semitrailers is normally limited to short distance transportation and feeder service. The container-shipment essentially shortens the turnaround times compared with the conventional piece goods handling as the following example shows:

handling capacity of one bridge: 25 - 30 containers/hr

with an average gross weight per container of 10 tons the handling capacity of the bridge is in average 280 tons/hr

accordingly the loading or unloading of 3000 tons of piece goods will take $\frac{3000}{280}$ = 10 hrs per bridge

By means of conventional piece goods handling this would take 30 hours (see 3.02).

Besides even two bridges may be used and with twin-lift handling two containers (20 ft) can be hoisted at one time.

3.06 Roll-on-roll-of techniques

The previously mentioned container handling at seaports is also called lift-on/lift-off technique. Roll-on/roll-off techniques have been developed from the long known ferry transport. Containers on chassis and various other heavy transports are moved in and out through bow or stern hatches (gates)

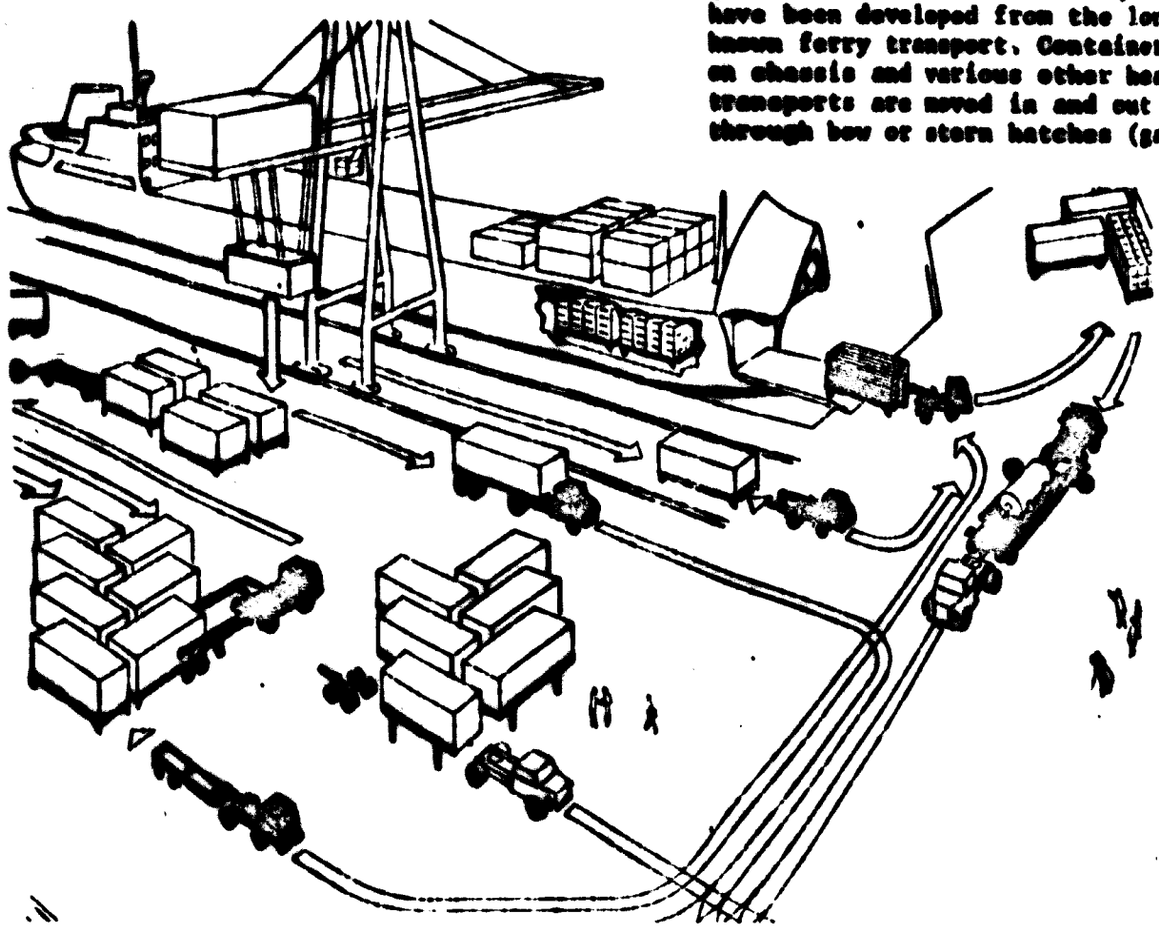


figure 28

by means of crossovs. Hoisting over board is avoided and no cranes are needed at all. Suitable ramps however for the roll-on/roll-off transport must be provided in the harbour.

3.05 Lash System

The Lash (lighter aboard ship) system is generally a barge-carrier system. The dimensions of the barges, (also called lighters or containers) are:

length	= 18,75 m
width	= 9,40 m
height	= 3,30 m
maximum net load	= 370 tons
maximum total weight	= 385 tons
maximum draught	= 3,00 m
empty draught	= 0,90 m

The Arcadia Forest can carry 73 barges (see figure 29).

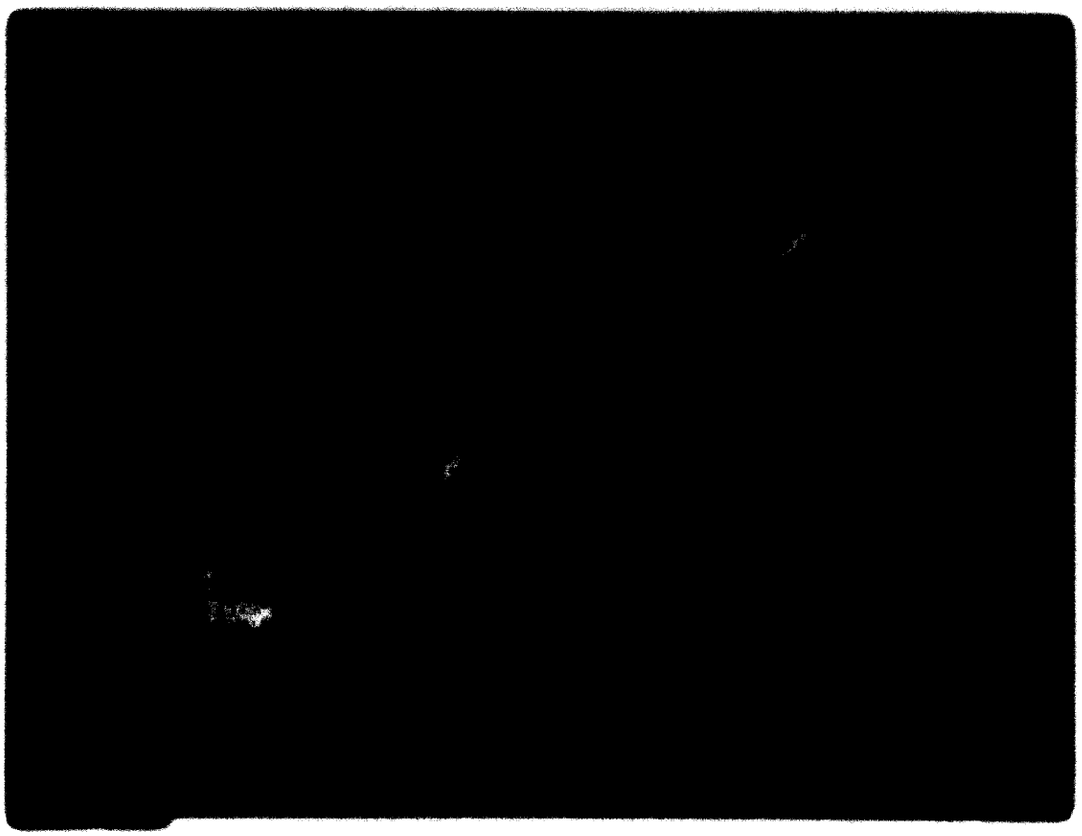


figure 29

A crane travelling on deck with a capacity of 510 tons picks up the barges at the stern, or drops them there respectively from where they travel on as push units. The handling capaci y of the lash-ship is:

operation time	15 min/barge
handling capacity	4 barges/hr
average net load/barge	~ 200 tons
average handling capacity	~ 800 tons/hr.

5000 tons of piece goods handled by means of lash system thus require 6,25 hours as compared with 18 hours for container handling and 50 hours for conventional handling. It must be taken into consideration however, that the lighters must be loaded and unloaded.

The fundamental idea of this system is to avoid the turn-round times in the harbour completely and to pick up or unload the barges on roadstead. The system saves the ship a lot of time, especially in places with long turn-round times as it the case in South America.

There are great advantages in countries with barely developed harbours as in many parts of Africa and Asia. Certainly the supply of the goods in time is problematic as well as the total performance of the barge traffic loaded and unloaded, inside and outside of the harbour the weather conditions on the roadstead will also be of importance especially for the push units.

Although this system was introduced not long ago, already now it can be forecast that it will become an important factor in sea transport.

3.07 Other carrier systems

A great number of ship yards and shipping companies are busy with carrier systems, other than the lash-system. These are also barge-carrier systems all of which are still in the design phase. Two systems are mentioned here:

Barge carrier of the Lykes-Lines

At first the whole carrier ship was scheduled to be

flooded, similar to a floating dock, to enable the barges to float in. For this system however, a depth of the sea of some 3o meters was necessary which is scarceley found near the coast. Presently Lykes examines the "sea-bee project" which is planned to carry barges with a net load of 85o tons. The barges are to be hoisted by a synchronized lift-platform to the stern and then hauled into the loading deck or vice versa.

Bloom & Voss, "Travelling-Port System"

This barge carrier provides a flooded chamber in the middle of the ship into which the barges are manoeuvred. They are picked up from there by a deck travelling crane (similar to the Lash system) and carried to the loading deck.

3.06 Trends in storing techniques

Two reasons for the enormous development of storing techniques are decisive:

- The high costs companies have to face and the great reserves of rationalization in each store.
- By the use of pallets or containers basic technical prerequisites were existing. The loading units were nearly identical.

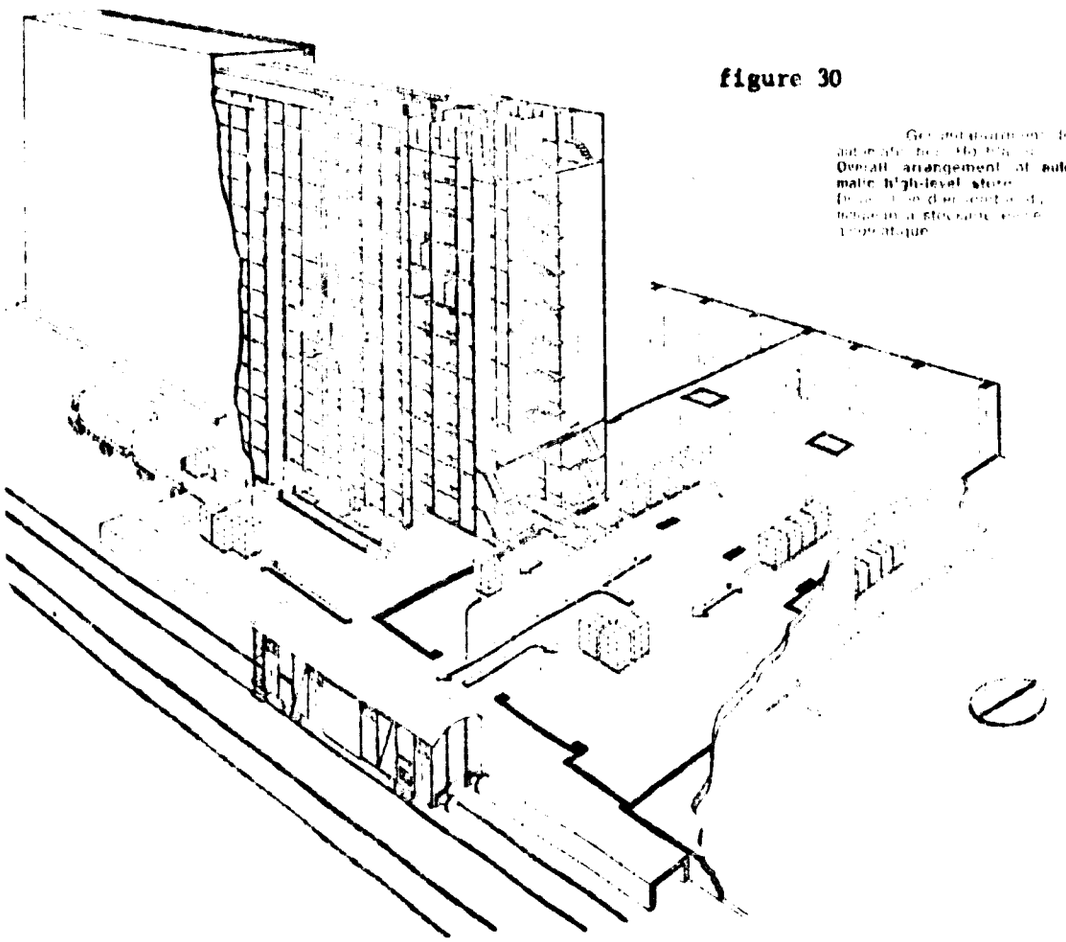
Within the scope of this report only some essential points of storing techniques can be mentioned.

3.06.1 Types of storing

- Flat stores need relatively large areas. The store may also have stacks, partially as continuous stacks. To be used if dimensions, type and weight of the storing goods differ. Handling is done mostly by fork-lift trucks.
- High level stores are between 7 to 8 (and up to 3o m) of height, with stacks and stacking lifts The store may be designed partly as transit store.

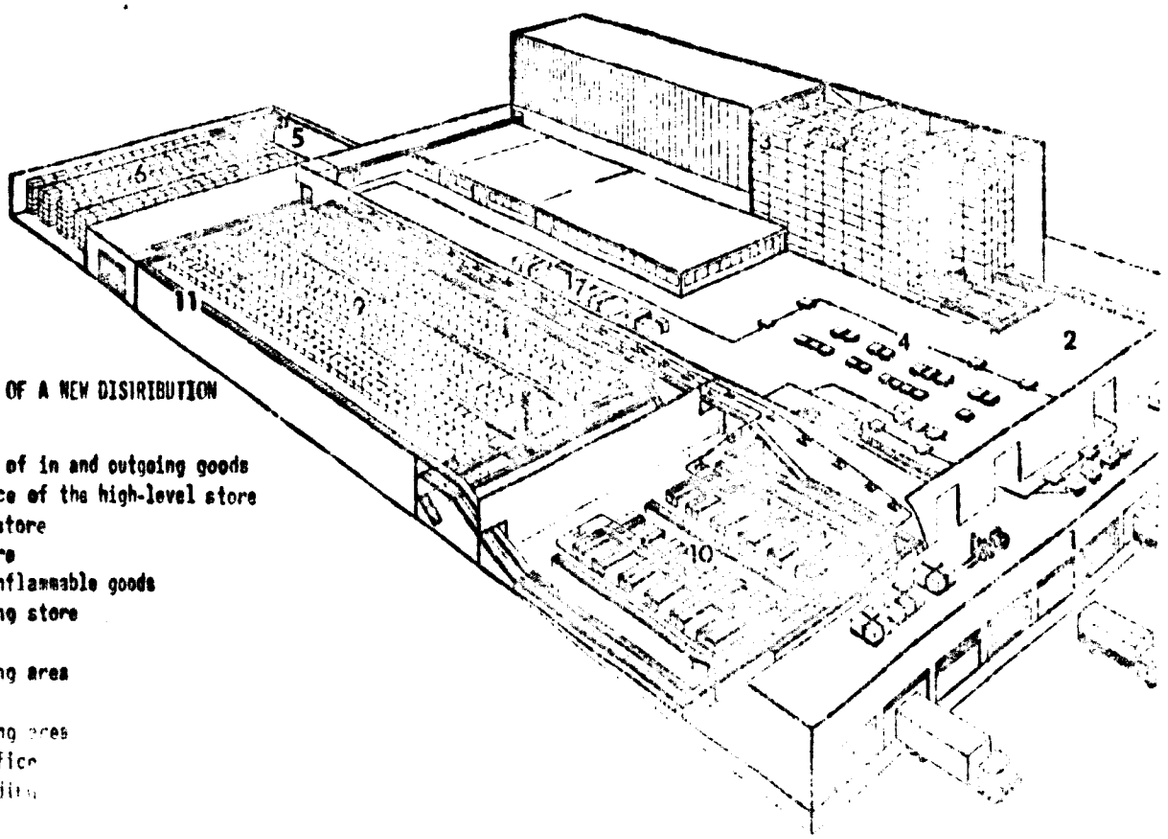
Figures 3o and 31 show modern stores.

figure 30



Overall arrangement of automatic high-level store

figure 31



SCHEMATIC VIEW OF A NEW DISTRIBUTION CENTER

1) Disposition of in and outgoing goods
2) Griding place of the high-level store
3) High level store
4) Sorting store
5) Store for inflammable goods
6) Refrigerating store
7) free store
8) large packing area
9) Grab store
10) Small packing area
11) Starter office
12) Filling building

- Transit stores all of the goods move continuously or discontinuously. The stacks are most efficiently used. Automatically the rule: "First in - first out" is guaranteed. It is used for food stuffs, etc.

An important operation in storing is the "consignment" (picking of orders). That means the arranging of goods of various kinds in compliance with an order. In this manual work mostly cannot be avoided. There are 2 main kinds of arranging:

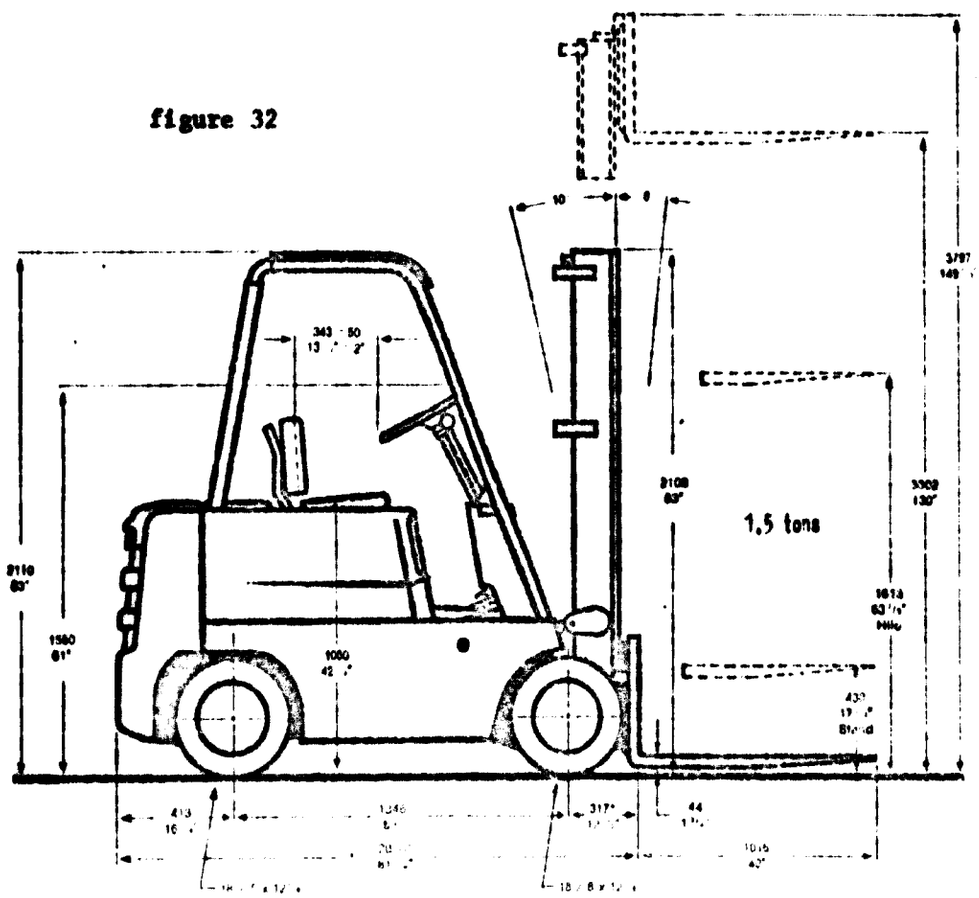
- The consignor is automatically taken to the different storing places where the goods are taken and the order arranged accordingly.

- The storing units are sent in a whole to the consignment area, there the orders are arranged.

3.08.2 Store handling equipment

Most important is the fork-lift truck (figure 32) for the store goods handling.

figure 32



Even higher stacks are served by fork-lift trucks, mostly of special design. In the right side of figure 33 a slewing fork-lift truck is shown. With the use of high stacks various types of stacking lifts were developed. Figure 34 shows a special equipment for arranging of stored goods.

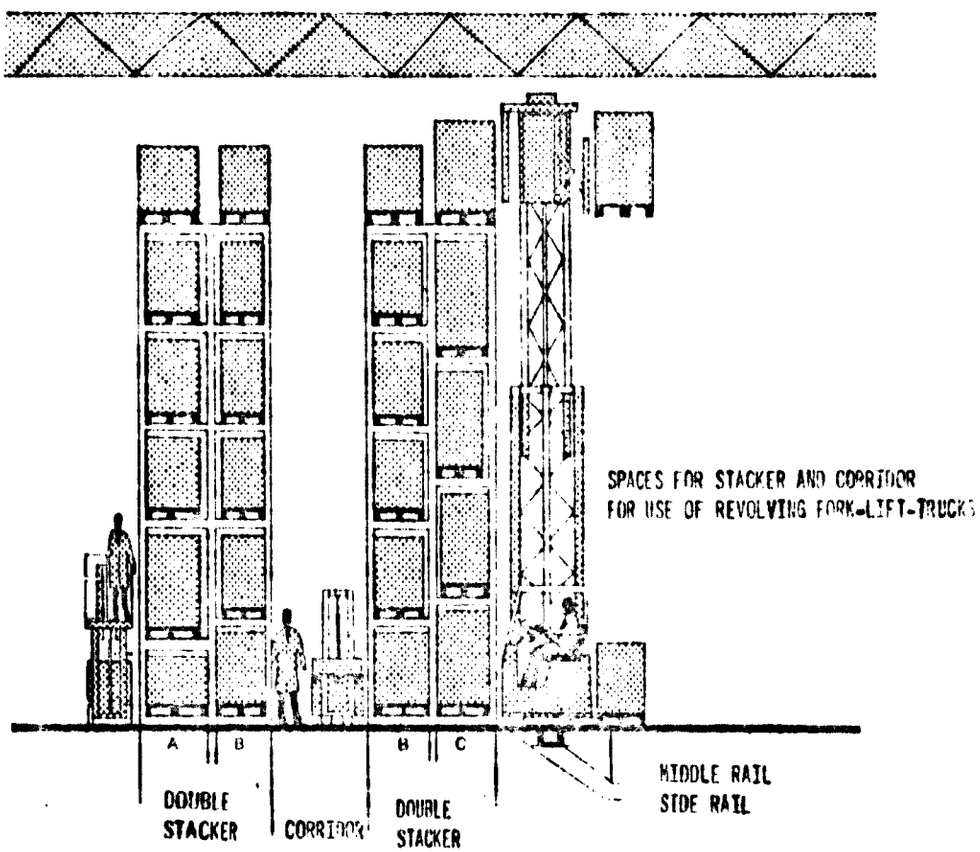


figure 33

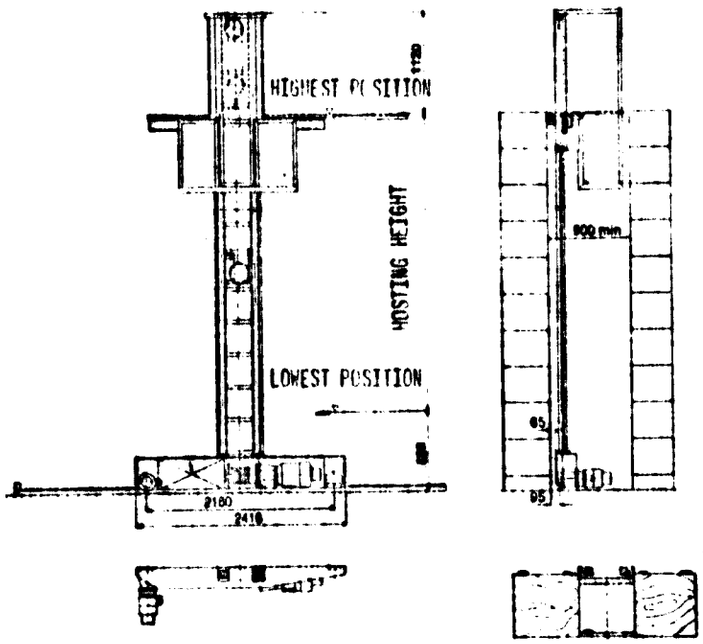


figure 34

Other stacking lifts are shown in figures 35, 36, 37. In figure 35 a punch card-controlled stacking lift as part of the total system in figures 36 and 37 bar-steel-high-level stores with lifts are shown.

To decide upon the question whether a stacking lift or a fork-lift truck will be more feasible, the following criterion has to be checked:

$z = u \times p$

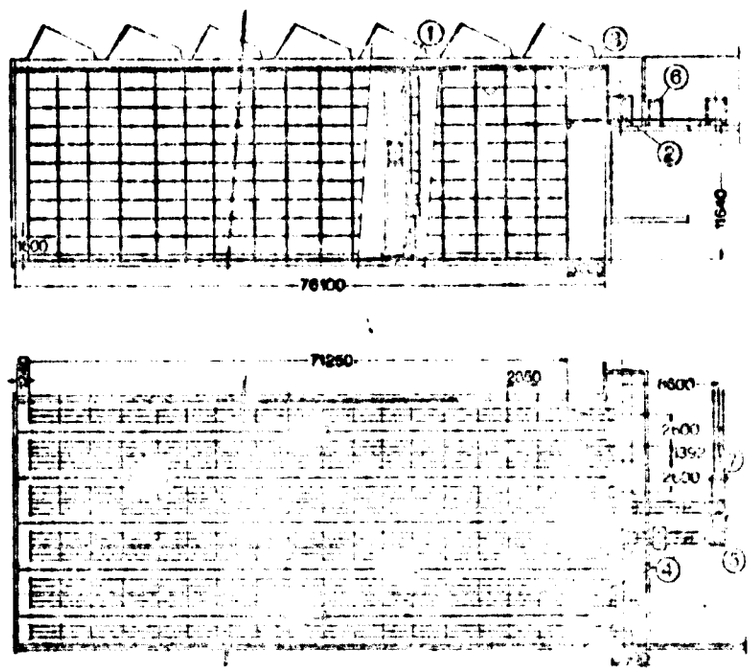
z = number of store handling equipment

u = store handling per time unit

p = period required by store handling equipment for one storing or picking cycle.

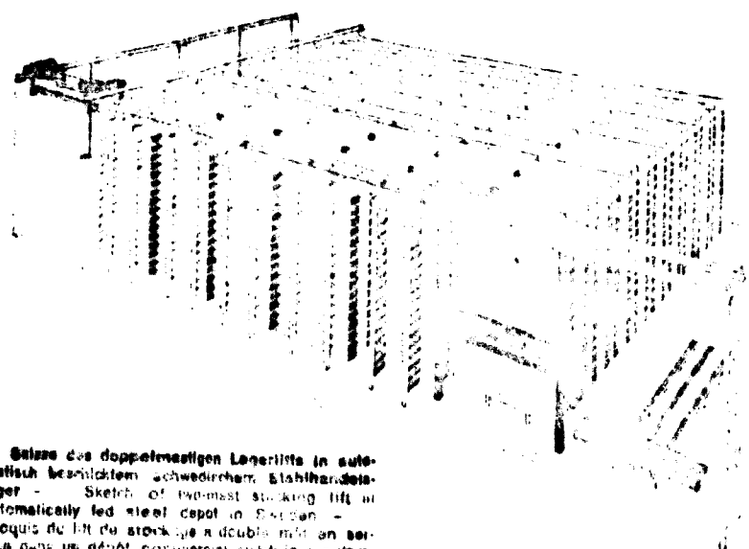
If (z) is much smaller than 1, a stacking unit is too expensive, a fork-lift truck should be chosen.

1) Punch card guided stacker serving equipment
2) Distribution carriage
3) Power supply and impulse transfer
4) Chain conveyor
5) Rigging area with lowering station
6) Control of profile
7) Pallet hoisting truck for removal



Automatisch arbeitendes Zentrallager mit Palettenumlauf zum Kommissionieren – Automatically operating central store with pallet circulation for order picking – Magasin central commandé automatiquement avec circulation des palettes pour la préparation des commandes

figure 35



Skizze des doppelmastigen Langerlifts in automatisch bedientem schwedischem Stahlhandelslager – Sketch of two-mast stacking lift in automatically fed steel depot in Sweden – Croquis du lift de stockage à double mât en service dans un dépôt commercial suédois à navettes, desservi automatiquement

figure 36

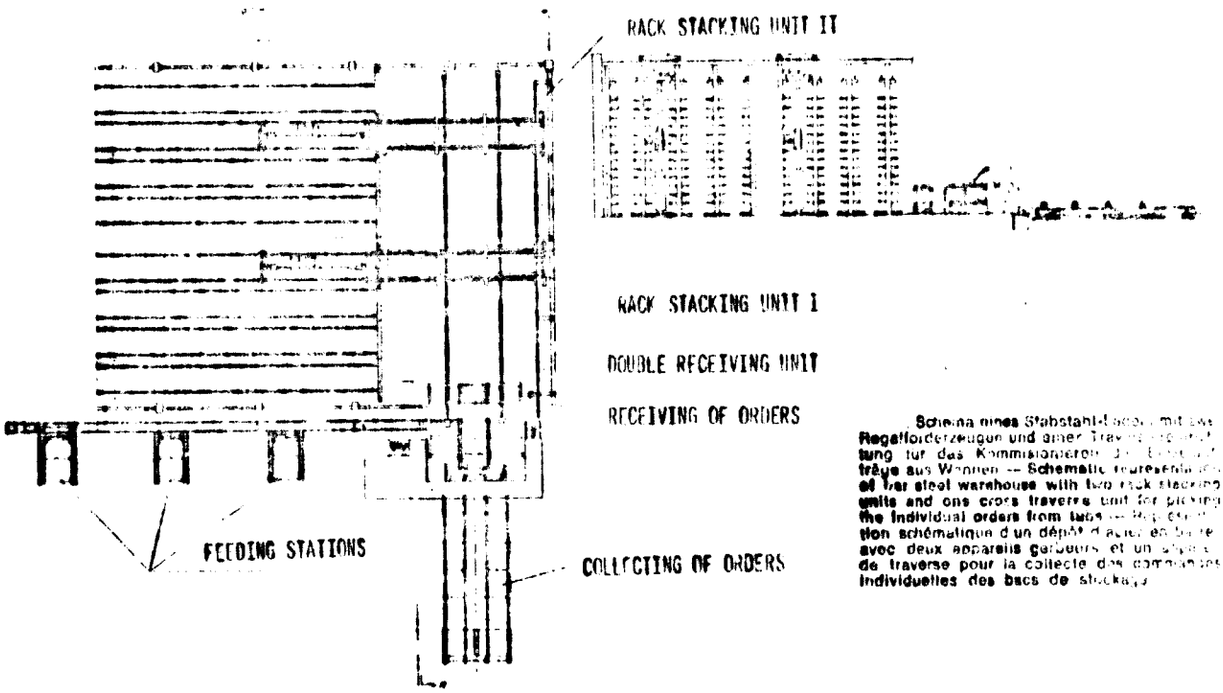


figure 37

3.08.3 Stacks

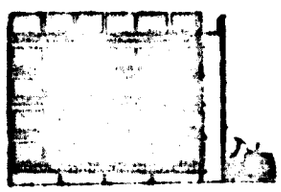


figure 38

The principal types of construction of the stacks are shown in figures 38 to 42. Figure 38 shows a pallet-circulation stack. The storing units are put in from the left side and roll on a decline way to the distribution side, where break rolls are provided. This design is in accordance with the "first in - first out" principle and results in a compact storing with high utilization of the storing area.

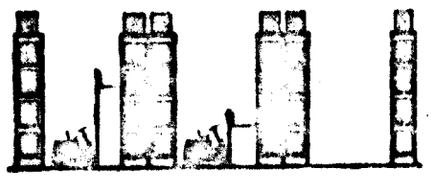


figure 39

Figure 39 shows a usual pallet-stack

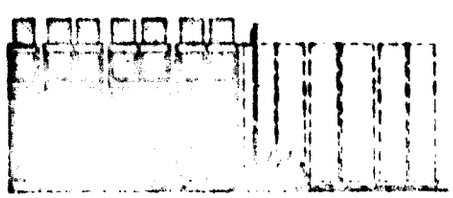


Figure 4o shows a pallet-sliding-stack on tracks. These stacks are not fixed, but are arranged moveable.

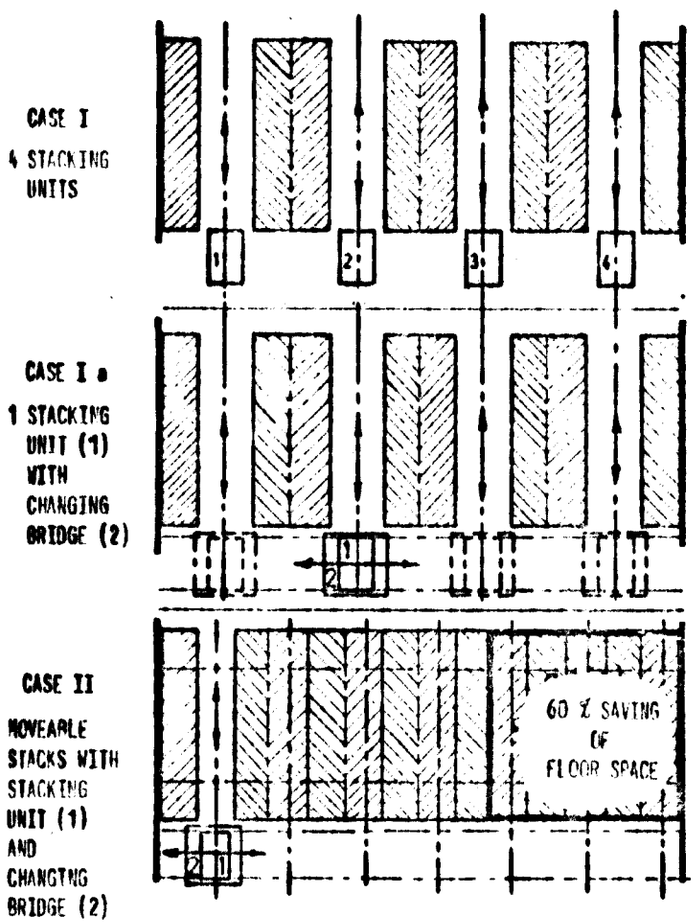


figure 41

The advantage of the moveable stacks is shown by the layout of utilization in figure 41.

Figure 42 shows a pallet-high-level-stack and figure 43 a high-level-stack with stacking lift.

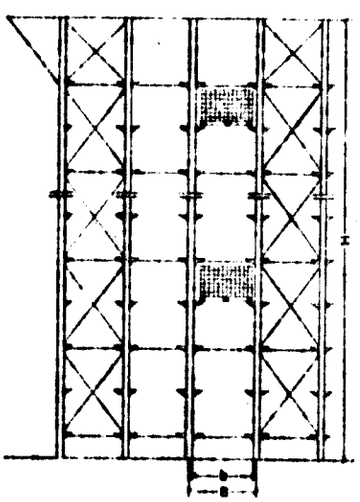


figure 42

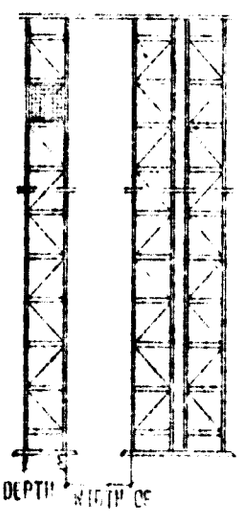


figure 43

The number of stack passages (R) results from:

$$R = \frac{e \times n}{2 \times l \times h}$$

e = frontal area of storing unit
n = number of storing spaces
l = length of stack
h = height of stack

The relation length/height ($\frac{l}{h}$) should be between 3 and 5.

3.08.4 Organization of storing

The organization to which techuical details must be adjusted is of main importance for the storing techniques. For each kind of organization at least 2 modes of data are necessary for identification:

- data of type (of goods)

- data of destination (storing place, shipping place)

For larger stores punch cards are used as basis for further processing. Three main groups are distinguished generally:

- Tub file and punch card reader

  (Source of faults: cards may be interchanged by mistake)

- Tub file, punch card reader and puncher

- Computer, punch card reader and puncher ("on-line" operation)

3.09 Automation of material flow

To reduce interdepartamental costs as means of rationalization, the manufacturing, the interdepartamental transport and the storing have to be thoroughly investigated and considered as one unit. Hence a continuous flow of material develops. These measures on one side mostly require high investment costs, but on the other side they are the only chance for many manufacturers to produce (and sell) economically. Only low manufacturing costs enables a company to compete. If a flow of material already exists, the automation is possible as a further improvement. The automation allows to reduce the high personnel costs, at the same time often increasing the quality of the products. The figures 44 to 49 show some examples of material flow and automation.

Abfüllanlage mit Lagerzonen für volle und leere Fässer und Gebinde –
: Filling facility with storage zone for full and empty barrels and canisters –
: Installation de remplissage avec zones de stockage pour fûts pleins et vides et récipients

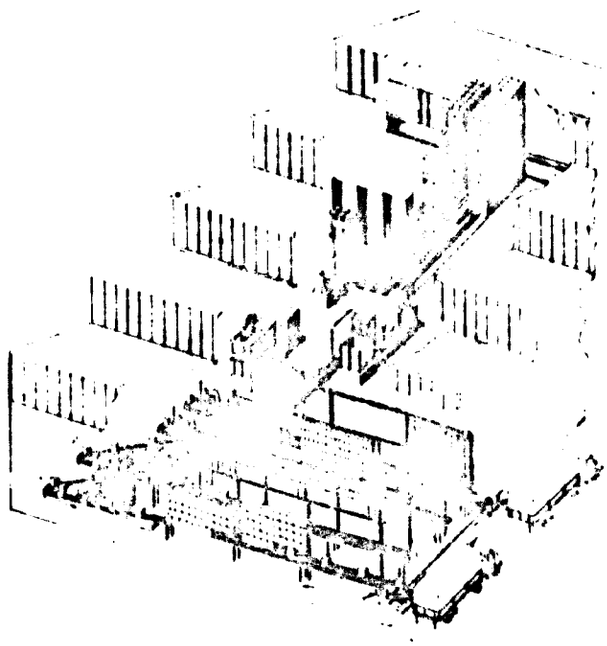


figure 44

Figure 44 shows a filling facility with storage zones, figure 45 the system of material flow for goods packed in cardboards.

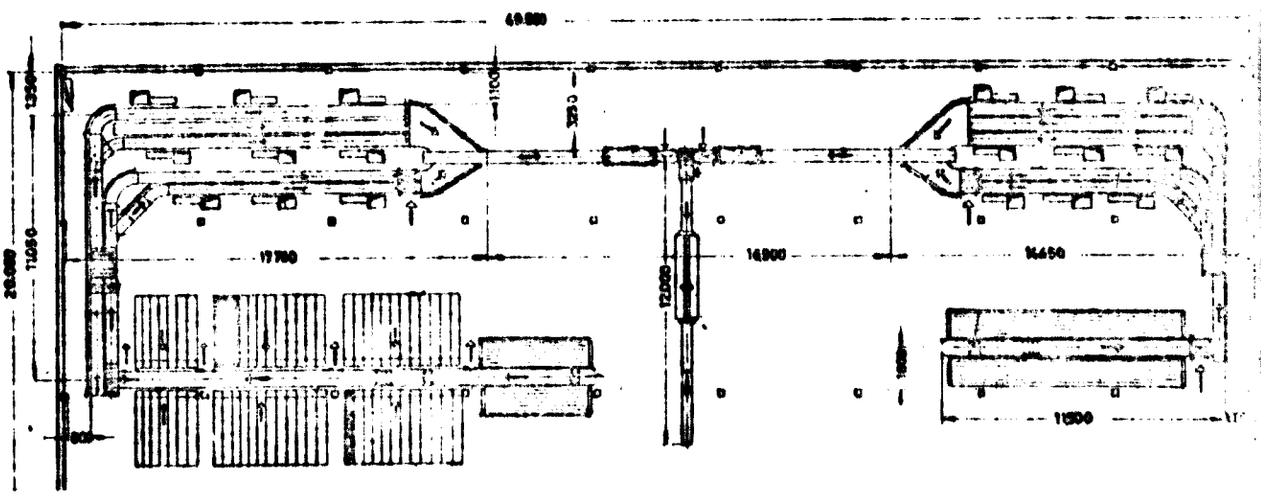
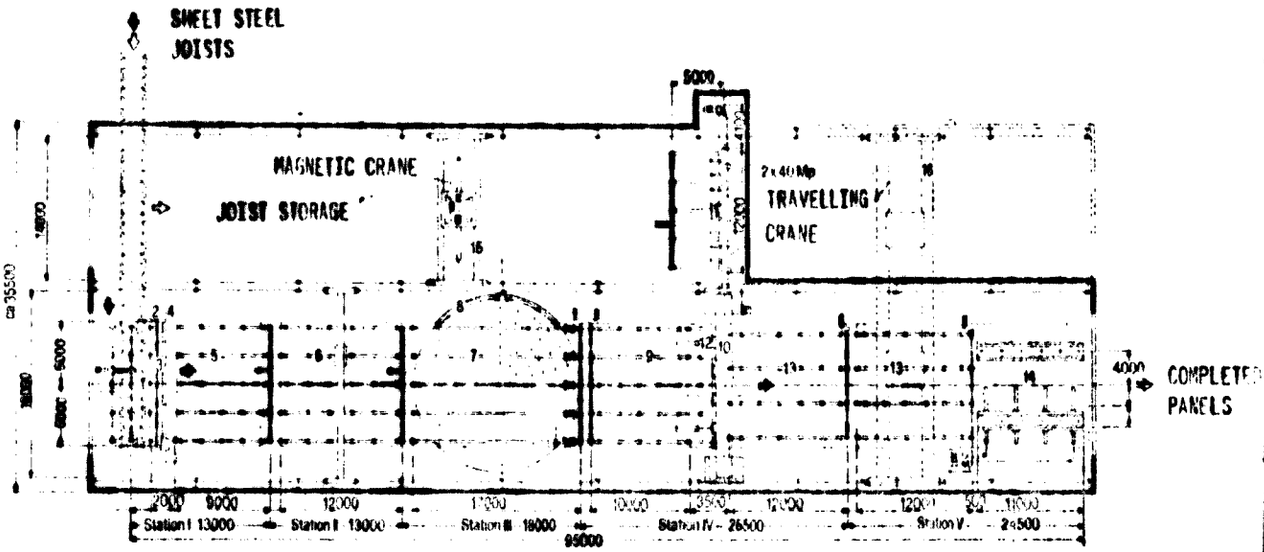


figure 45

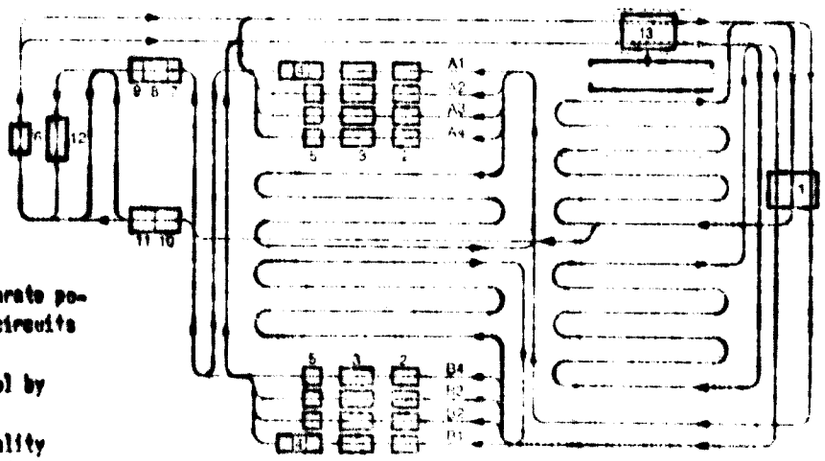
Figure 46 shows the material flow for the prefabrication of ship construction, the manufacturing of panels of a modern dock yard.



Gesamt-Anordnung der Paneelstraße -- : General arrangement of panel line -- : Disposition générale de la ligne à panneaux

figure 46

Figure 47 shows the system of material flow of one part of a tire manufacturing plant. The material flow is achieved by a circular handling equipment.

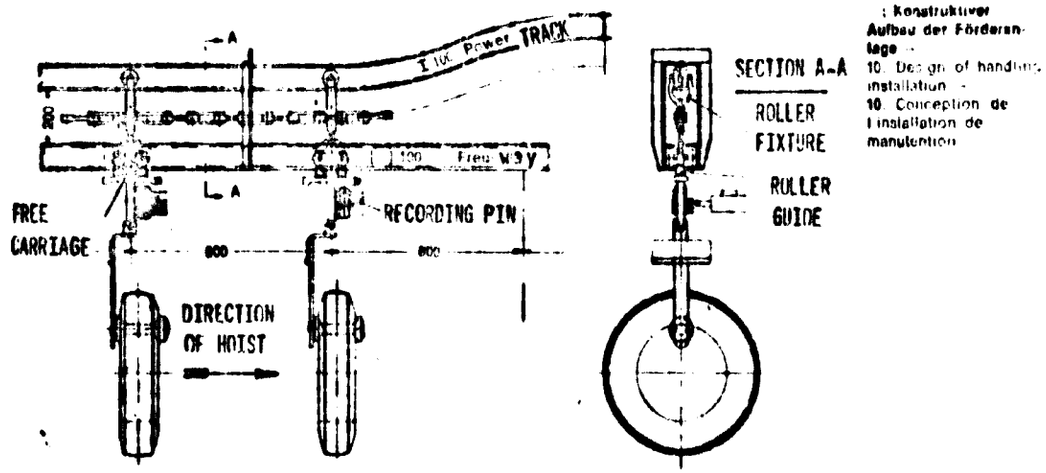


1) Tire feeding on two separate po-
wer -and-free-conveyor circuits
2) Automatic dresser
3) Manufacturing and control by
personnel
4+5) Automatic control of quality
6) Control of quality of radial
and special tires
7+8+9) Sealing of white side tires
10+11) Surface treatment
12) Assembly of spikes
13) final sorting

Material flow plan and routing arrangement of
Power and free-Conveyor

figure 47

Figure 48 shows the design of the handling equipment.

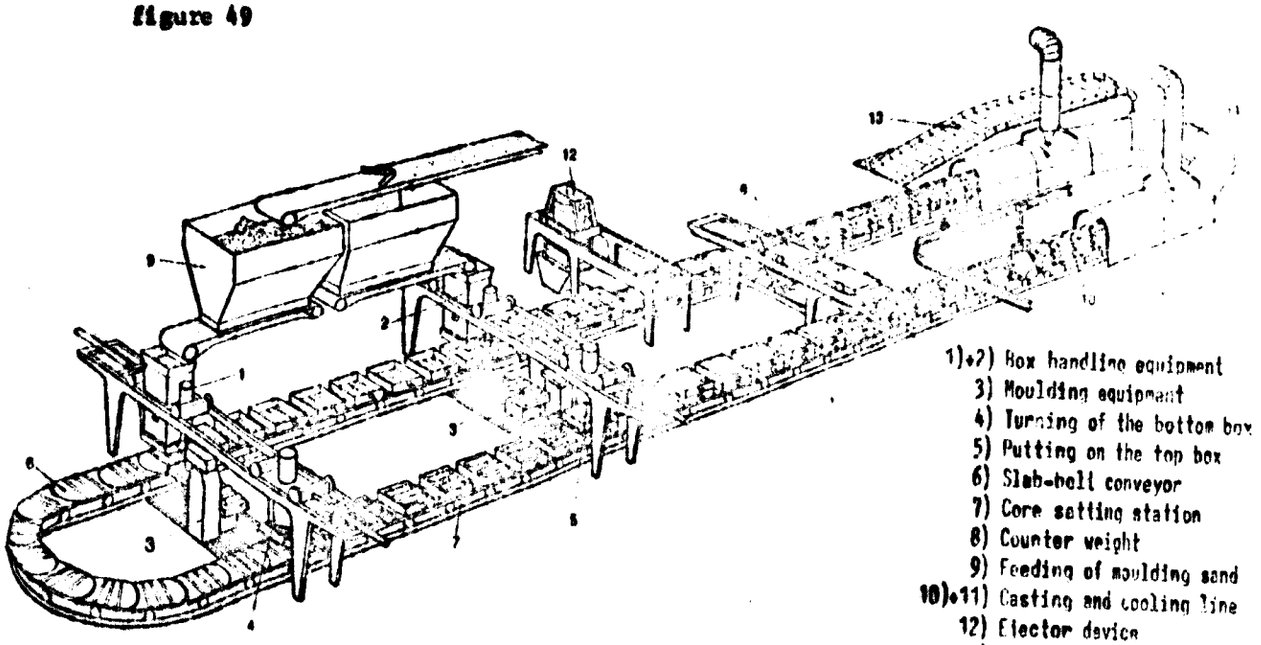


: Konstruktiver Aufbau der Förderanlage –
10. Design of handling installation –
10. Conception de l'installation de manutention

figure 48

Figure 49 shows the automated material flow of a foundry plant.

figure 49



Ausführungsschema automatischer Formanlagen – 1: Construction scheme of automatic moulding plants –

These few examples reveal that the conventional cranes do not fit into the material flow of a plant. Accordingly they have been displaced already to a far extent. For a crane manufacturer it is a conclusive necessity to study the material flow of production plants to enable him to elaborate suitable proposals and quotations.

The suitable way to adapt oneself to the special circumstances leads first to the appropriate load lifting equipment.

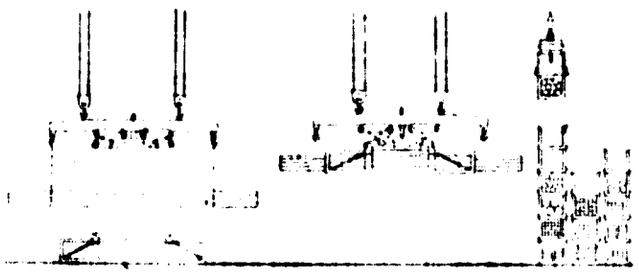
3.10 Load lifting equipment

All manufacturers are engaged in the improvement of their products and the reduction of their costs.

To achieve these goals new equipment and furnishings are examined as soon as they are offered on the market or at least when they become known. The manufacturers of such equipment and furnishings therefore always try to offer their customers new ideas and proposals to ensure contracts and the desired turnover.

Crane manufacturers usually do not follow up this line, but prepare a quotation only after receiving a request. A further shortcoming of the crane manufacturers is their idea that their responsability ends at the crane's hook". This primarily had the result that the conventional built crane was less and less suitable to meet the rationalized handling requirements. The first step to overcome this problem led to detailed studies of the load lifting equipment. Often by constructional measures regarding the crane better handling methods can be found.

Single-point load-fixing for instance often is very disadvantageous. Figure 5o shows a cable suspension, automatic lifting tongs and the use of loading frames for the handling of long material. This solution has led to clearly arranged storing and has cut down the manual work extensively. This is only one of the numerous possibilities to make a crane more attractive again.



Principle of the automatic lifting tongs for handling of long material in stack frames. The frames are picked up automatically. A fixing by hand is not required.

figure 5o

The second step leads to fundamental reflections on cranes in general. Often the heights of lifts and the trolley travel gearing are by far shorter than provided by a crane. Therefore new ideas should be approached to develop more simple and cheaper constructions for instance by the use of hydraulic cylinders. Above all the scope of work of the handling equipment must be considered in connection with the material flow. Most likely very often equipment will be developed which has only little relationship with a crane, for instance the combination between a crane and a machine tool or an automatic welding machine. The latter has been accomplished for the production of panels. (see figure 46).

3.11 General views on bulk material handling

In the worldwide trade, bulk material has gained more and more importance. The demand for raw material has increased by growing industrialization. The local sources of raw material of the industrial countries often are not sufficient in quantity, processing not economical because of minor quality or not existing at all. On the other hand, today it is technically possible to ship large quantities of raw material over large distantes at reasonable prices and hence to supply the required quantities and qualities. For developing countries often the export of raw material is the only source of income.

Many new developments have been achieved in the field of bulk material handling. Some main improvements of the

equipment were obtained like horiyontal transport by belt conveyors. Many things however are still not satisfying like the taking up of material by grabs, the capacity of which is limited, or means of vertical transport.

The situation of the mechanically working handling equipment is marked by the evolution to high efficiency special equipment linked with eachother by belt conveyors. Only with regard to unloading of ships the manual operation of the equipment could not be avoided.

Prospects of bulk material handling are certainly to be seen under various aspects, one of which seems worth to mention:

The main raw material suppliers, the developing countries, have serious problems in the near future because of fast growing population. An increase of production and export will become imperative not only to guarantee sufficient food but also to guarantee a contenting standard of living. Certainly the trade with raw material will not be enough, semi-manufactured goods will have to follow. Similar to the change in the wood trade sector in which the delivery of the raw material "wood" was superseded by the delivery of cellulose or paper. This development trend will increase and change many a production flow of the basic industries.

3.12 Ship loading equipment

Nowadays shiploading equipment is only designed as belt conveyors with a relative high individual capacity of each equipment. For breakable goods only special designs are made.

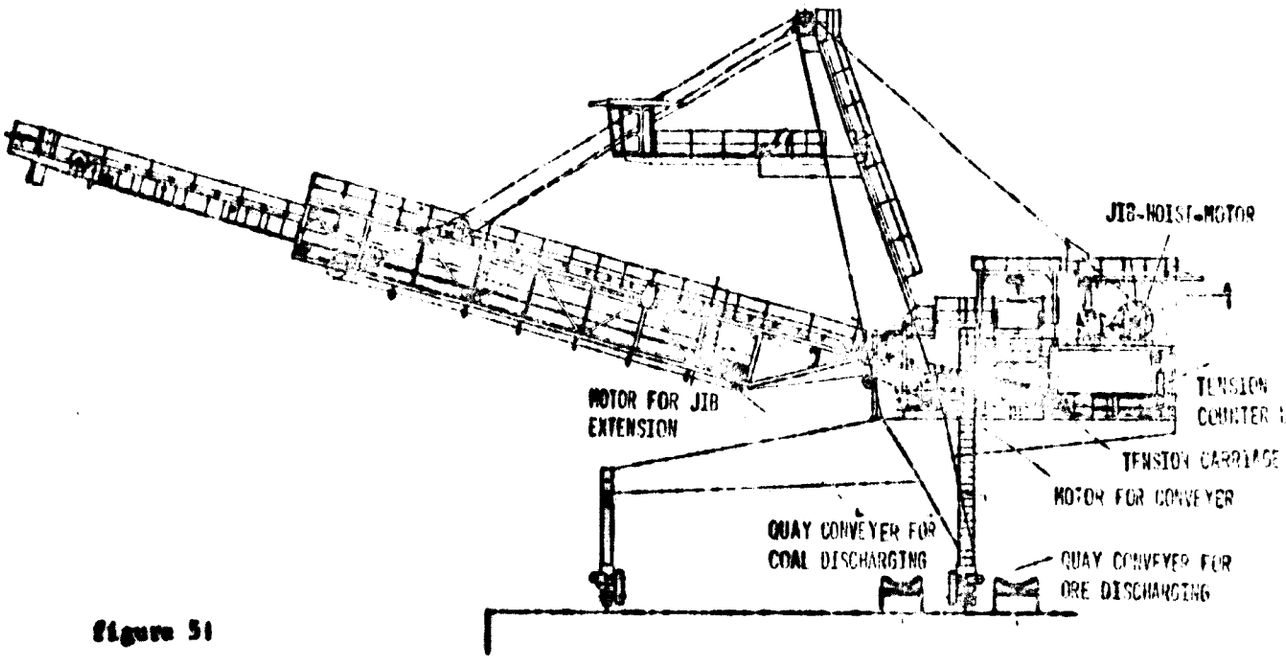


Figure 51

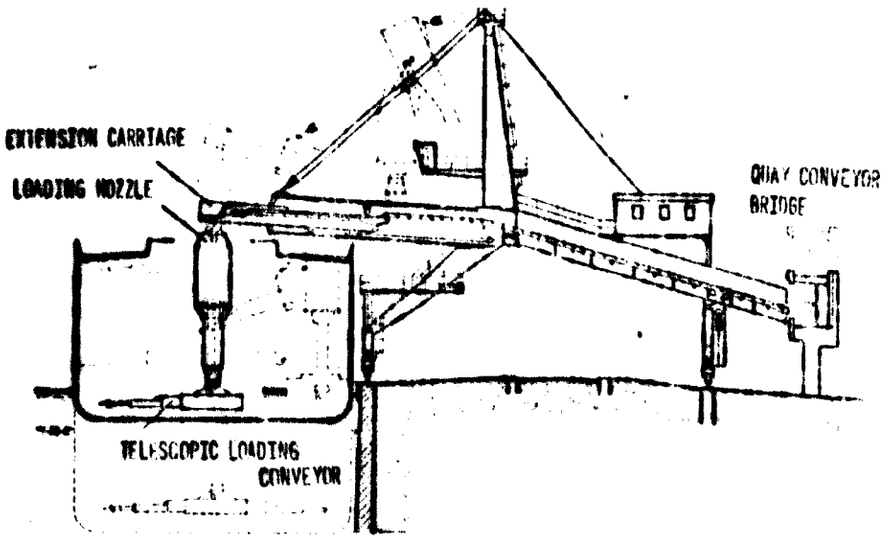


Figure 52

Übersichtsskizze des Schiffsbeladers mit möglichen Auslegerpositionen – General sketch of ship-loader with various boom positions – Croquis d'ensemble du chargeur de bateaux avec différentes positions possibles de la flèche

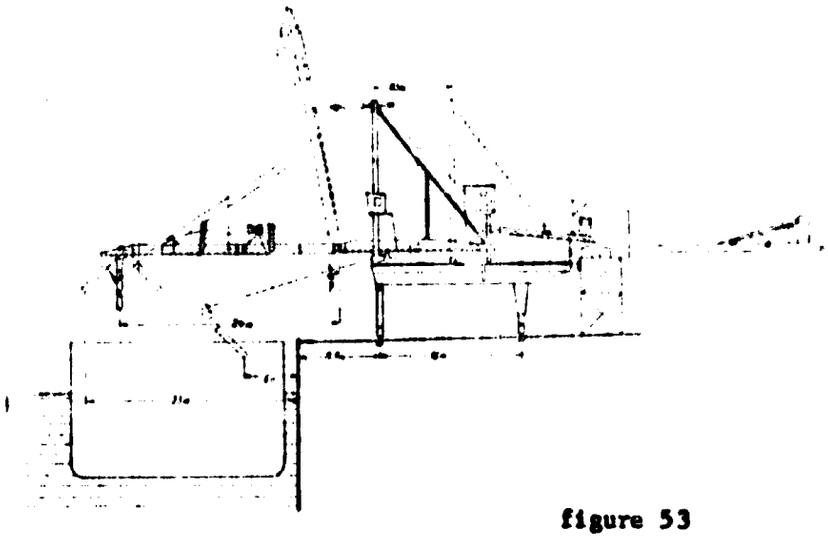


figure 53

Figures 51 - 53 show shiploaders for seagoing ships which are used mainly for handling of ore. The capacity is mostly between 3ooo and 6ooo tons per hour. But also loaders with smaller as well as with higher capacities are built.

For the loading of inland ships smaller loaders are sufficient. For this purpose the capacities are some 2ooo tons per hour. Figure 54 shows an inland shiploader.

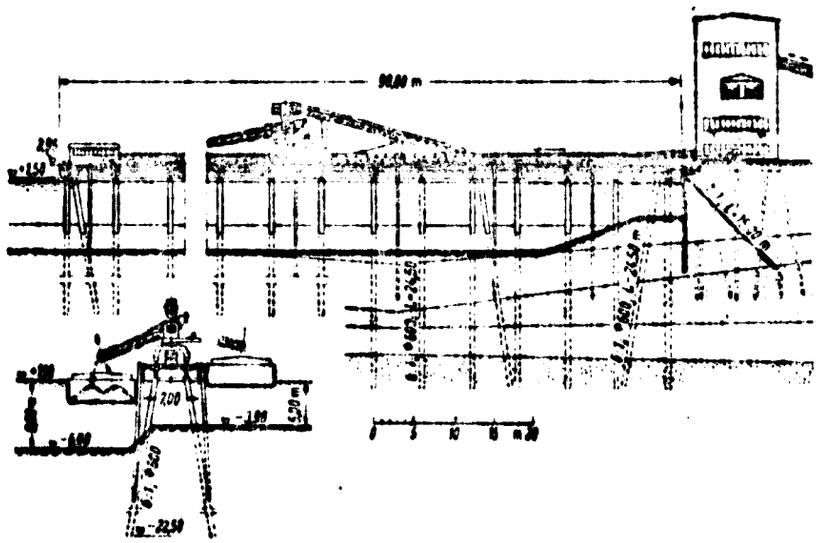


figure 54

3.13 Ship unloading equipment

Still today the unloading of ships is done by grabs. Although this discontinuous handling is not satisfactory, it is the only economical solution for the time being.

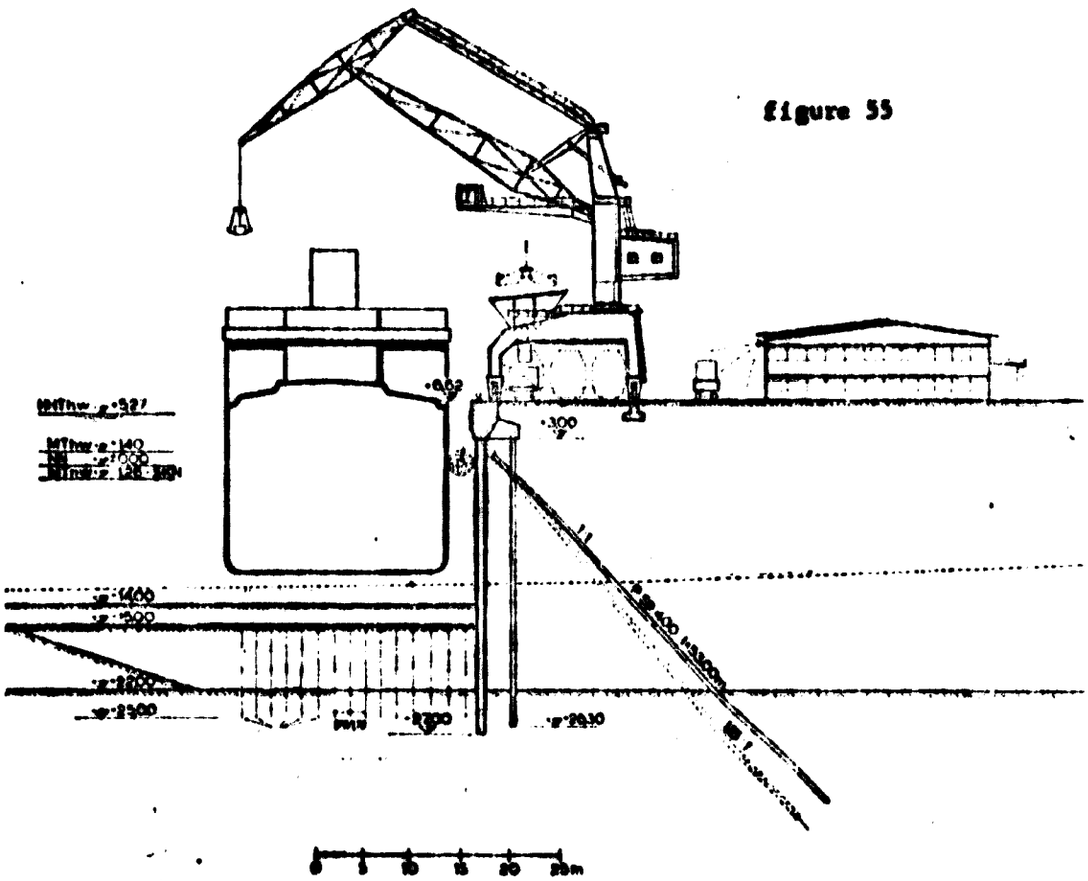


figure 55

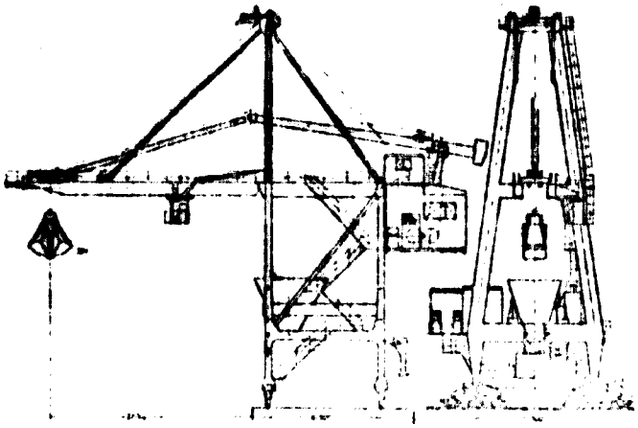


figure 56

For smaller capacities - up to 4oo tons per hour - grab cranes are used, working in the "kangaroo system" (figure 55). This system provides for a silo on the water side so that the working cycle of the crane consists only of hoisting and luffing. The silo usually is linked with the belt conveying system by means of an outlet facility (vibrating gutter or plate conveyor).

For higher unloading capacities, up to 2ooo tons of ore per hour unloading equipment as short - bridge- unloaders are used (figures 56, 57).

These unloaders are equipped with cable-line-trolley-carriages to keep down the construction weight of the bridge and the wheel loads at the waterside. For the bridge in figure 56, the grab cables are led over a steering knuckle arm (same as for the double guide crane) to keep the grab at the same height when the trolley-carriage travels. The unloader according to figure 57 matches this by use of an additional auxiliary trolley carriage to be seen in the arrangement of the cables in figure 58.

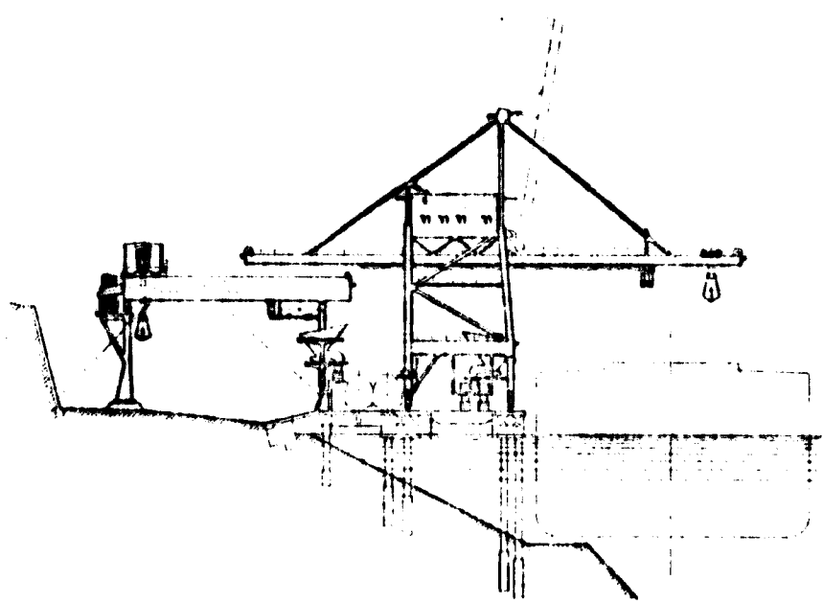


figure 57

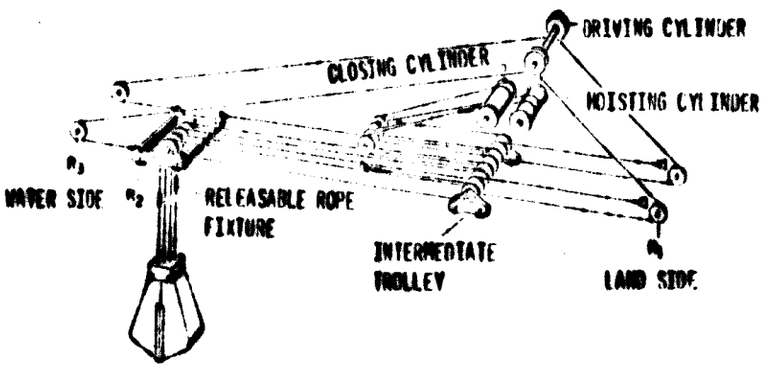
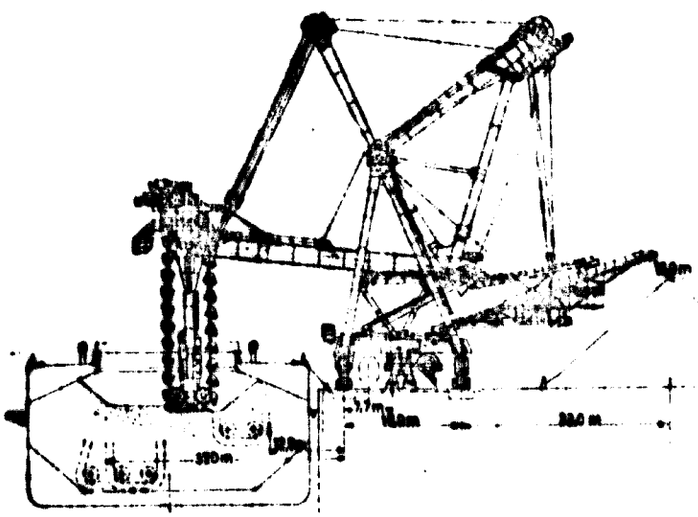


figure 58

Besides the grab unloaders continuous conveyors, bucket-wheel and bucket-conveyor-unloaders have been projected and some already constructed. Also some self-unloading-ships are designed but a general use has not yet been achieved. The technical difficulties are considerable and the capacities are only scarcely higher than those of the grab unloaders. Figure 59 shows a projected bucket-chain-unloader for 2000 tons per hour, of the "conflow system".



„Conflow"-Landanlage

figure 59

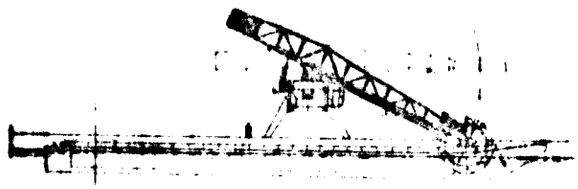


figure 6o

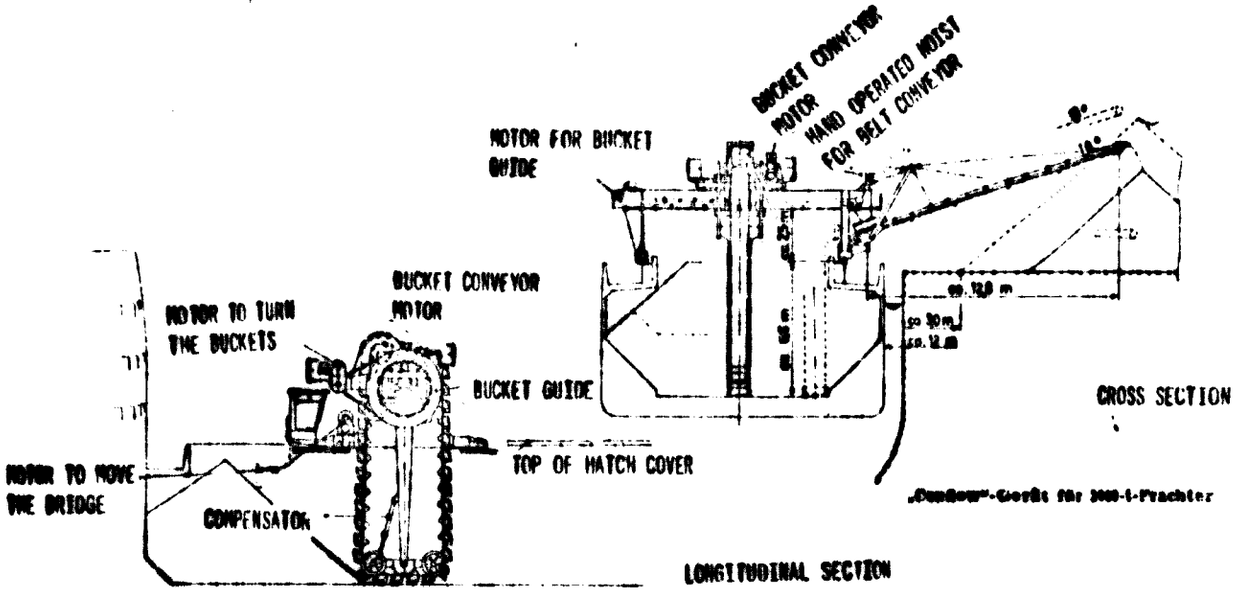


figure 61

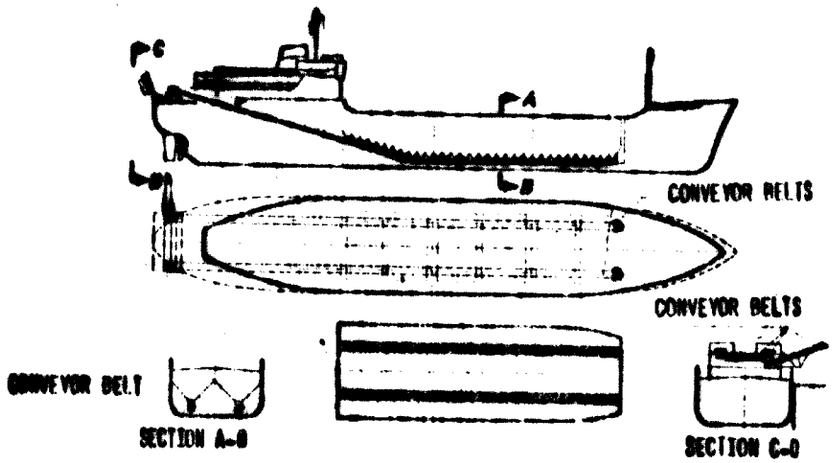


figure 62

Figure 6o shows a constructed bucket-wheel unloader for inland ships.

Figure 61 shows a constructed built-in-ship "comflow equipment", a bucket-chain dredger for lignite with 45o tons per hour capacity.

Figure 62 shows a self-unloading-ship. The freight space is built like a silo below which two outlet conveyors transport the goods to a transverse conveyor at the stern.

3.14 Handling equipment for storage yards

For bulk material which is stored in stock yards on dumps, like ore and coal, the following equipment is required for loading out and reclaiming:

	loading out	reclaiming	
1.	conveyor-dump-bridge	grab bridge	(figures 63 - 65)
2.	dumper	bucket wheel	(figures 67 - 69)
3.	combined bucket-wheel	dump equipment	(figure 70)
4.	dumper	grab crane	
5.	loading bridge with overhead grab crane		

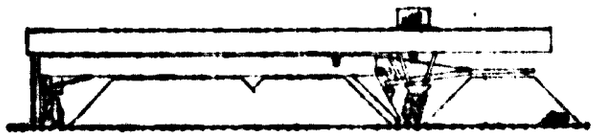


figure 63

. Aufbau der Plattenbandbrücke für die Lagerplätze F
– : Design of yard loading bridge for storage yards F –
: Construction du pont de mise en tas pour les parcs de stockage F

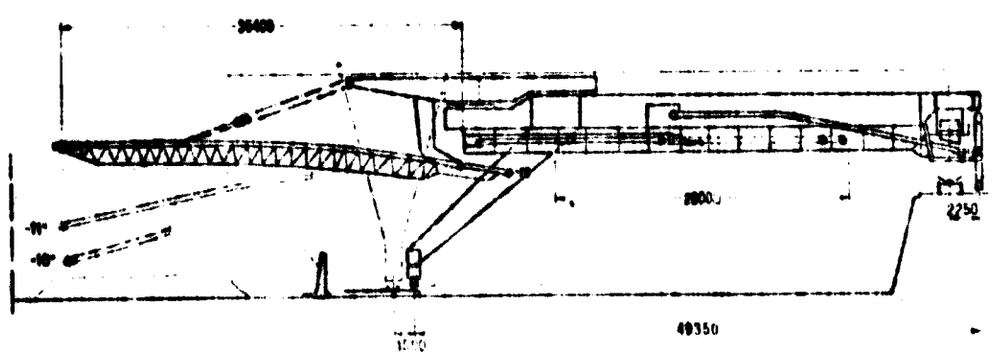


figure 64

figure 65

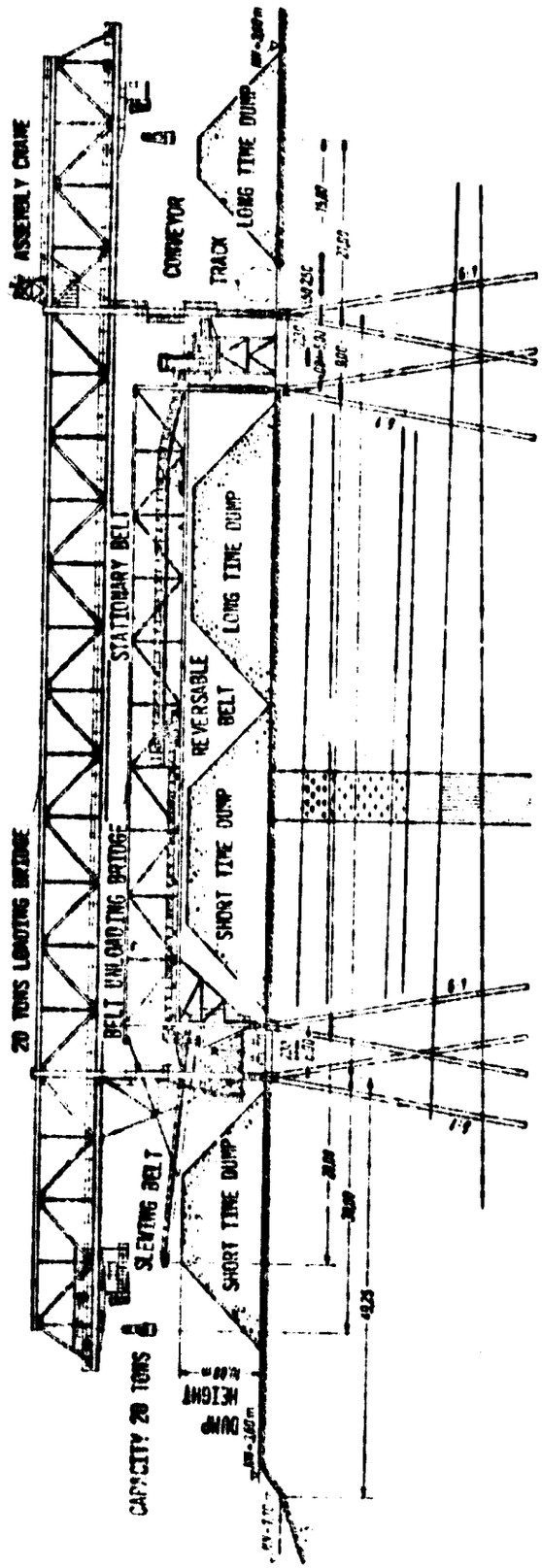
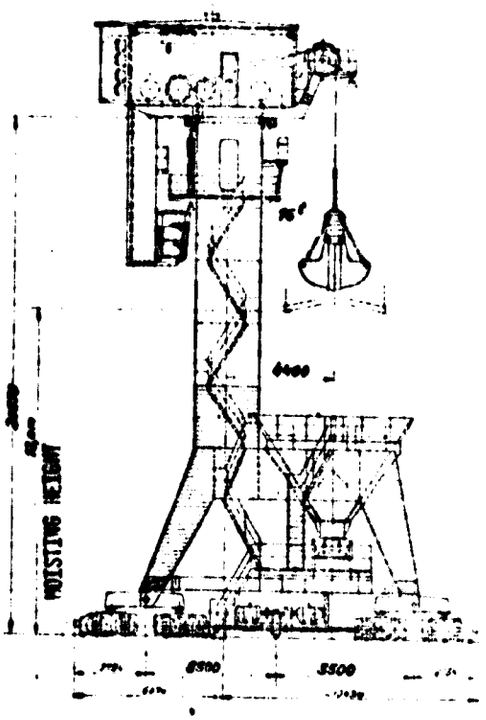
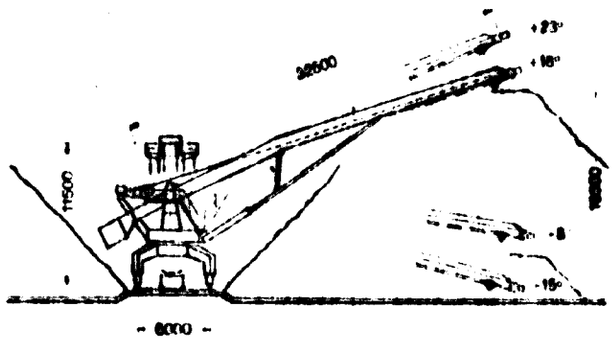


figure 66





: Aufbau der beiden drehbaren Platzbelader für die Lagerplätze B und C –
: Design of the two slewing yard loaders for storage yards B and C –
: Construction des deux engins de mise en tas rotatifs pour les parcs de stockage B et C

figure 67

Schaufelradlader für Beschickung und Rückladung auf einem Kohlenlagerplatz in den USA. Beschickungsleistung 1500 t/h, Rückladeleistung 1000 t/h. Haldenquerschnitt 480 m² — Bucket wheel loader for loading out and reclaiming on a coal stockyard in the United States. Loading out capacity 1500 tons per hour, reclaiming capacity 1000 tons per hour, operating range 480 square meters — Roue pelleteuse pour la mise en stock et la reprise sur stock sur un parc à charbon dans les États Unis. Capacité de stockage 1500 t/h, capacité de reprise 1000 t/h, champs de travails 480 m²

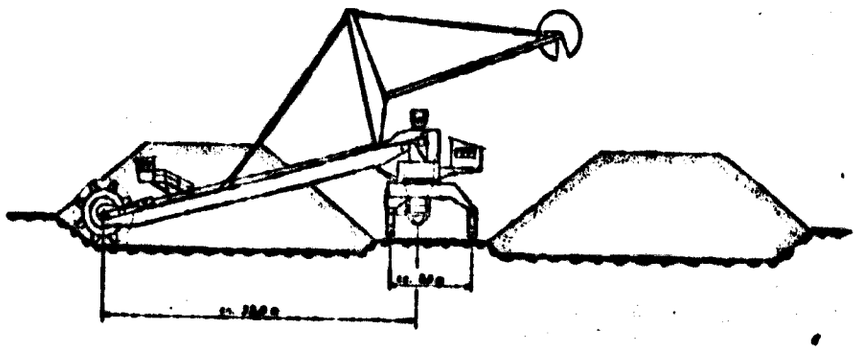


figure 68

Schaufelradlader auf Raupenfahrwerken für eine Förderleistung von 400 t/h. Die Verbindung zur Bandstraße wird durch eine Teleskopbrücke hergestellt. Abtragbarer Haldenquerschnitt auf jeder Seite der Bandstraße 115 m² — Bucket-wheel loader on crawler units with a capacity of 400 tons per hour. The connection the belt conveyor is by means of a telescopic bridge. The loader has a cutting range of 115 square meters on either side of the conveyor line — Roue pelleteuse sur chariots sur chenilles ayant une capacité de 400 t/h. Un pont téléscopique relie la roue pelleteuse et la bande transporteuse. La portée effective de travail est de 115 m² des deux côtés de la bande transporteuse.

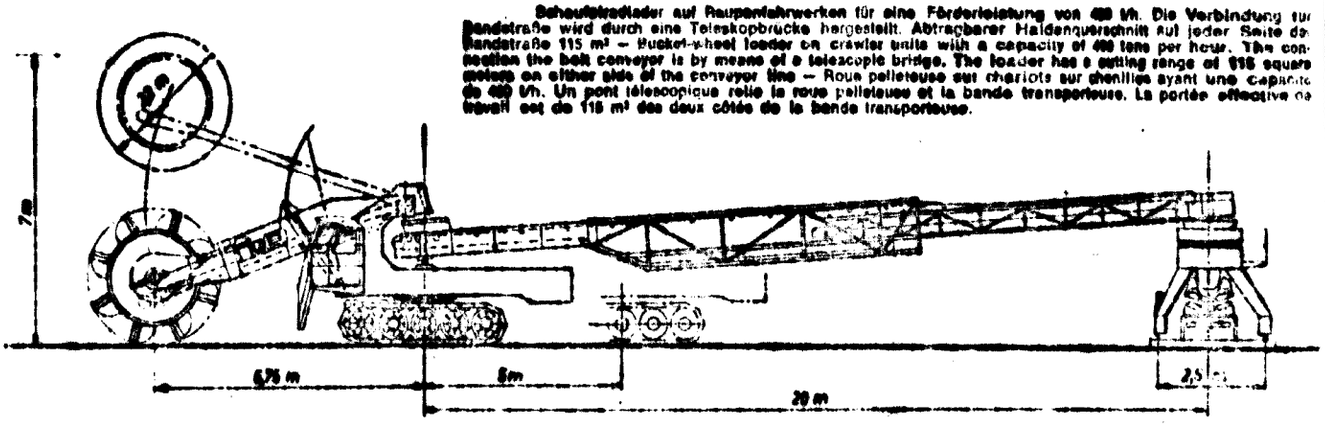
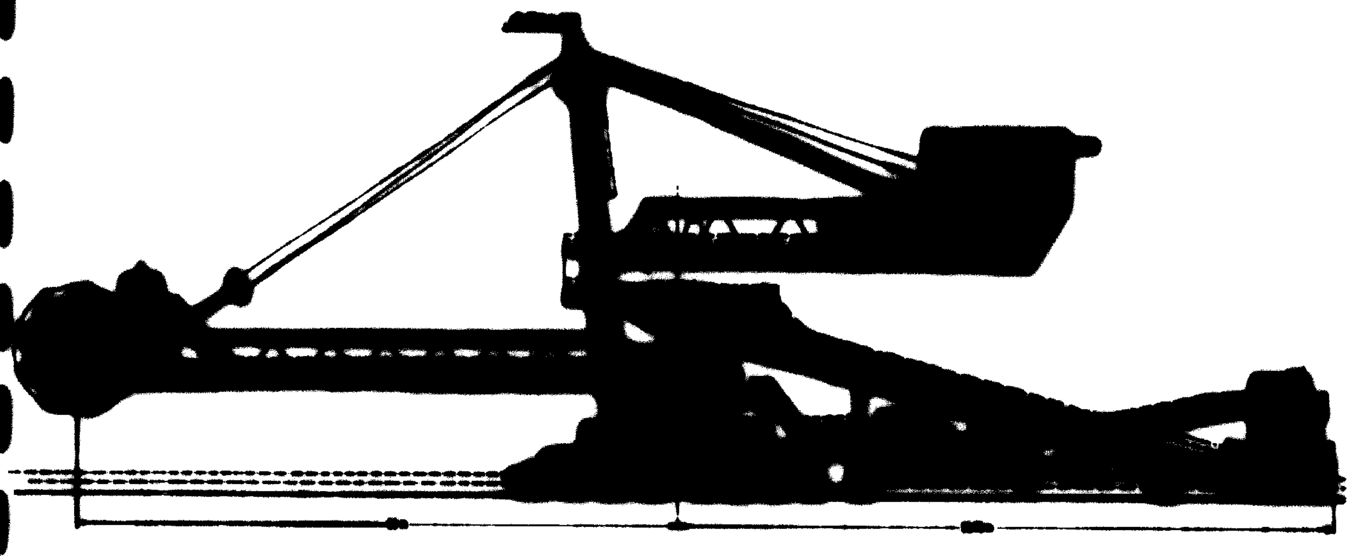


figure 69



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3.15 Belt conveyors

By use of belt conveyors not only the problems of horizontal handling was solved nearly perfectly, but at the same time the prerequisites were given to link various equipment and systems with each other. The belt conveyors offer numerous solutions, this already can be apprehended from the variety of belt installations and placings of the drive (figure 71).

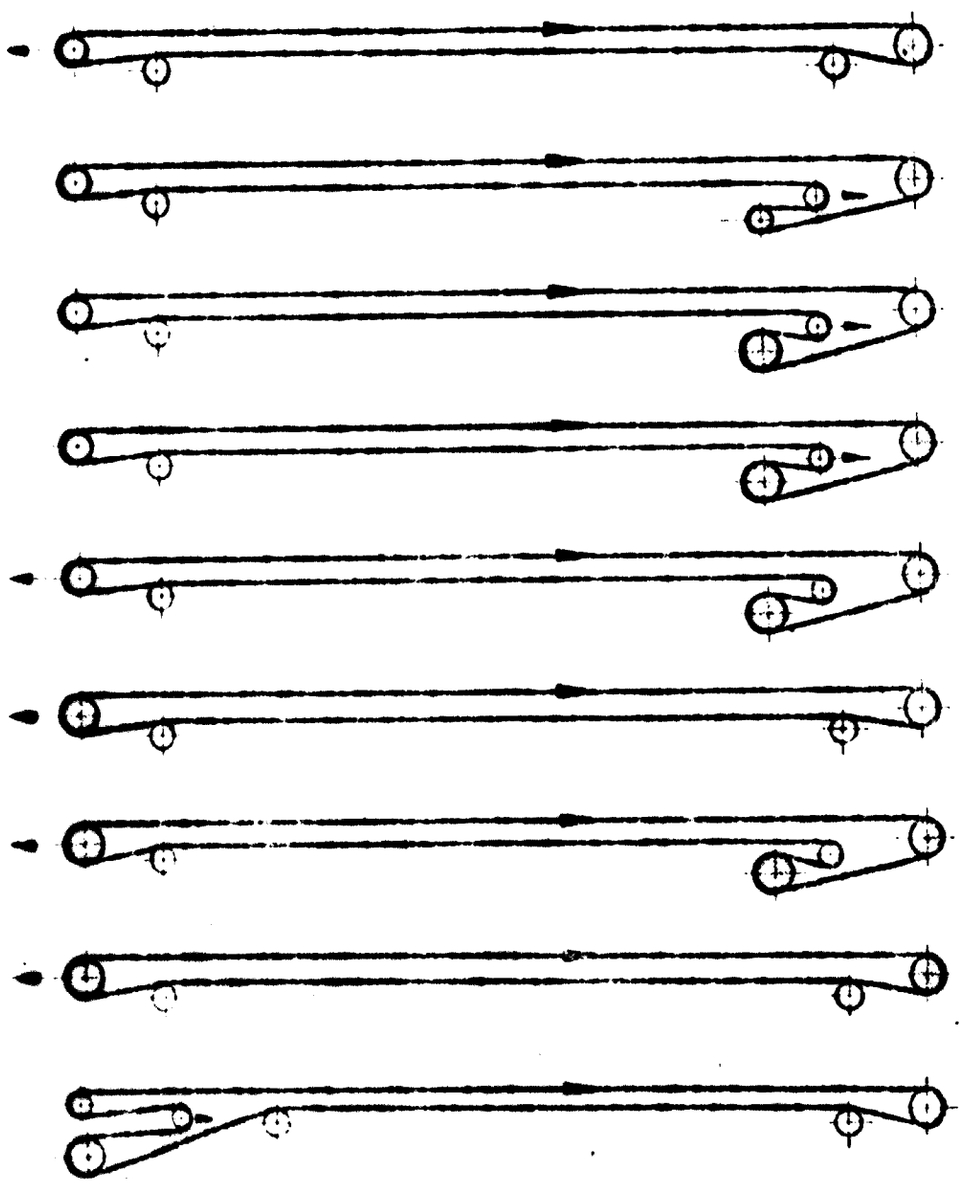

figure 71

Figure 72 shows the installation of the belt drive, figure 73 a frequently used belt section.

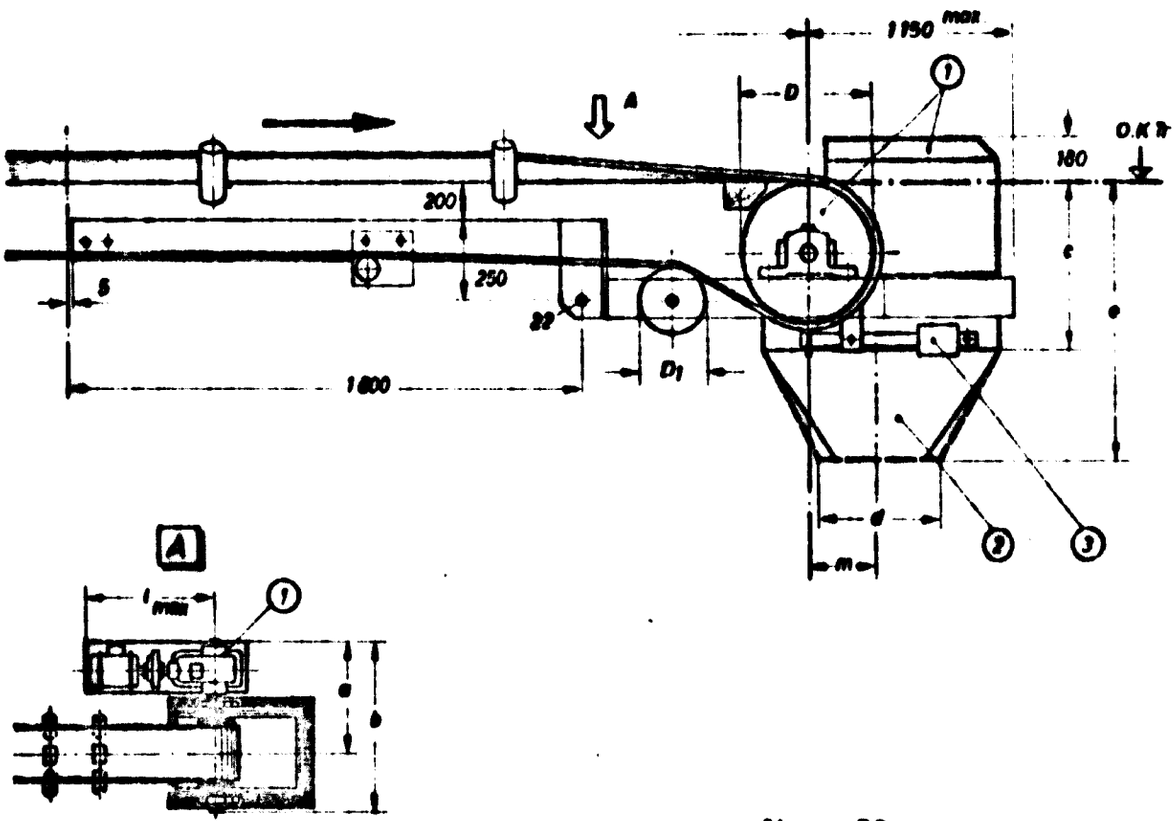

figure 72

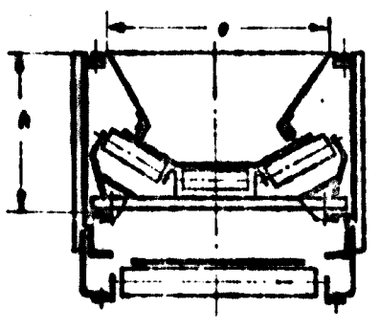

figure 73

3.16 Automation of conveying flow

With the application of belt conveyors continuous material flows for the first time were worth mentioning. This continuous handling has been the best prerequisite for automation.

Larger bulk material handling facilities today mostly work automatically, the basis of which is the organization that realizes all the decisive factors. With the help of computers the quantities to be called off will be determined, equipment will be set into operation or stopped. The material will be weighed and weighing documents as well as shipping papers automatically issued. In a central control station the whole handling system is represented symbolically on a large illuminated table. At any time signals indicate which parts of the plant are in operation. The most important transportation data are also indicated at the control station, so that the controlling personnel can correct operations if necessary.

The crane producer has to take into consideration that, whereas until recently bulk material loading has been executed by grab only, now more and more bucket-wheel loaders are used in the stock yards.

Only for unloading of ships the grab could hold its ground. Certainly this way of unloading will not last very much longer as the disadvantages of the grab operation mainly result in a bad profitableness of the handling plant. Today the maximum capacity of grab handling equipment is 2000 tons/hour, when handling ore. Average equipment handles 1000 tons/hour. Belt conveyors are designed for much higher outputs. A further disadvantage of grab equipment is that it needs an operator even for invariable operation, such as removal of a dump.

Without doubt, the further functions of the grab cycle after picking up the goods can be automated such as trolley carriage movements, discharging into the silo and returning; by this the operator will be relieved of some work but nevertheless is still necessary.

Bucket-wheel equipment does not show these disadvantages and can also be designed for capacities corresponding quite well with belt conveyors. The higher wear of this equipment is more than compensated by the lower purchase and energy costs and offers the premise for automation.

In this field the manufacturer of conservative cranes will have to face declining demand, too, which makes it necessary to adapt himself to the above mentioned development.

PART A

Recommendations

4. Recommendations

4.01 General

The general development in the field of handling techniques has to follow up the tasks outlined by the cost reducing application of material flow systems required by the industry. There will be very good chances for all types of handling equipment which fit in easily in such a material flow or make this flow possible. Cranes of present design show a recurrent trend except cranes of small sizes and special cranes. In Yugoslavia the handling technique may develop slightly different regarding the time factor but in principle the same problems will arise. Especially in the export business this general trend has to be considered.

Development trends reveal some important fields where further rapid progress will take place and - from the side of manufacturers of handling equipment - has to be followed up very closely. Other fields require only constant redesign and improvement of the overall and detailed constructions. Since individual courses of development permanently show minor variations and adjustments to changing requirements, it will be necessary to provide for a more thorough market research and market analysis. A permanent control of production quality and, besides, of produced equipment already delivered with regard to perceptible "weak points" both in quality and in design will render an important contribution to the continuous process of improvements.

Production control and improvement of produced goods lead to the fields of methods and procedures of manufacture as well as to standardization with its different ranges of application.

Existing capacities of engineering skills and experience should be utilized to reduce the use of constructions under license and develop own designs.

The success of a manufacturer depends not only on the high quality production of equipment constructed according to the most advanced design but to a large extent on selling-prices obtainable and on required production costs respectively. It will be necessary to apply every possible measure of rationalization to reduce production costs.

Recommendations can be given as follows:

4.02 Important future fields of material handling equipment

METALNA should pay particular attention to the fields of

- pallet transport and pallet storing with special regard to the advanced methods of automated systems.

- containerization in piece goods transport with the appropriate modern handling equipment and regarding the most recent developments (such as the lash-system).

- automation in bulk material handling with regard to bucket-wheel loaders and particularly to automated system of belt conveyors.

4.03 Market analysis

METALNA should provide for own market analysis up to a certain extent. At least the salesmen and agents of the enterprise should permanently study the views and opinions of prospective customers as well as changes in transport systems and report accordingly. Furthermore developments of competitors have to be observed closely. All data obtained should be evaluated statistically for the permanent access of the management of METALNA.

4.04 Manufacture

Generally more simple constructions (with regard to manufacturing) should be achieved by means of closer co-operation between the design-engineering and the manufacturing staff and by making more use of the on-the-spot experience of the latter. Special attention should be paid to the selection of appropriate and suitable material according to the different requirements. To increase the efficiency of manufacturing procedures particularly the automatic welding equipment should be used more effectively and replanished significantly. Besides, possibilities to apply advanced metalworking technology should be studied and implemented as far as applicable and favourable.

Further assistance is recommended in this regard by making available experts for an on-the-job assignment on

- application and utilization of automatic welding equipment

- application of advanced metalworking technology.

4.05 Standardization

The meaning of "standardization" as far as applicable to METALNA is threefold and METALNA should engage in each range:

- standardization of construction parts with the view to have more interchangeable parts (for different constructions) which can be produced more economically in larger quantities and to facilitate the problem of spare parts

- standardization of construction units also with the view to have interchangeable units suitable for different types of equipment again considering advantages regarding manufacture and spare parts. In addition the designer can always base his construction design on a certain part of fixed construction units with defined specifications

- standardization of equipment, particularly of small and medium bridge cranes, to have available a fixed programme of cranes with only a limited number of different lengths of span and lifting capacities.

4.06 Constructions under license

METALNA manufactures quite a number of items under license. Regarding the capabilities of its engineering staff METALNA should try to develop more own design.

4.07 Management and cost control

Rationalization necessitates a detailed investigation and comprehension of procedures and costs. This is achieved by means of systems analysis and systems engineering with the application of network techniques. The control of man-hours needed and the programming of the different production stages including the arrangements for material supplies can be facilitated efficiently only by using electronic data processing. While hardware is available by computer facilities in Ljubljana, standard software has to be adjusted to the particular conditions of METALNA and the appropriate systems installed and implemented.

Further assistance should be made available by assigning an

- expert in systems analysis and systems engineering to METALNA for the elaboration and implementation of suitable systems.

APPENDICES

ANNEX 1: History of METALNA

Since its foundation, METALNA, which is one of the leading Yugoslav machine construction firms, has been narrowly connected with the building of power generating plants and irrigation and navigation schemes. Today in Yugoslavia there is virtually no hydroelectric power plant without Metalna's hydraulic gates, cranes, penstocks and other hydraulic equipment.

When the Fala hydroelectric power plant on Drava river was built more than 50 years ago, a pretty well equipped constructional steelwork workshop was left on the construction site. After completion of the Fala plant, the workshop machinery and equipment were taken to the new workshop built at Maribor where the company Splošna stavbena družba, predecessor of Metalna, was established in 1920.

The workshop, which had then about 200 workers, developed and expanded with the years to a company having now 2800 employees out of which more than four hundred engineers and technicians, economists and other college educated experts. Long-standing experience, cooperation with renown domestic and foreign firms, scientific institutions and individual scientists, highly skilled workers, large design office, up-to-date equipped workshop covering more than 25,000 sq.m., modern outfit and apparatus for testing materials and final products, good organisation of work, application of modern manufacturing processes have enabled the company to attain a high technical level in the field of designing, manufacture and erection of equipment for power generating plants.

Water control equipment for hydraulic projects, cranes and other load handling equipment are among the principal items in Metalna's range of products. For many decades, the firm has been known also for construction of bridges, steel framed structures and tanks, whilst in the latest decades it has gained renown as manufacturer of refrigerating plants, ship's deck equipment and other equipment for metallurgical and chemical projects. The activities are not limited only to the delivery of items of equipment but also as contractor for single-responsibility service for complete projects and as supplier of complex plants.

It can be said that today Metalna enjoys an excellent reputation in this country and abroad, particularly as maker of

cranes and other materials handling equipment as well as water control equipment and penstocks for hydraulic projects. 2o power plants abroad and 67 power plants and navigation canals and irrigation schemes in Yugoslavia are outfitted with Metalna's equipment. In total, the firm has built so far 12o,ooo tons of this kind of equipment.

Only in the last two decades Metalna has built more than 1,3oo cranes for shipyards and harbours, steel mills and power plants, wood industry, building industry, etc. The firm has developed and improved numerous special types of cranes (see annex 3: Cranes and other Materials Handling Equipment Produced by Metalna).

In the last 3o years, about 6o power plants have been built or are in course of construction in Yugoslavia. Only two of these are not outfitted with Metalna's equipment. The fact that Metalna has received the order for delivering more than 9,ooo tons of equipment for the Djerdap (Iron Gate) Hydroelectric Power Plant bears witness of the trust and confidence it has gained with the clients.

In spite of keen international competition, Metalna has been awarded more and more contracts abroad, particularly because of the high quality of its products and its numerous and important references. The following projects are equipped with Metalna's cranes, water control equipment and penstocks: Awash I and II, Adola and Tis Abbai in Ethiopia; hydroelectric power plants: Matatila Dam, Yamuna hydroelectric plant, Hirakud Dam and Panchet Hill Projects in India; Chichoki Mallian and Gujranwalla Projects in Pakistan; Ahlad and Koyulishar Projects in Turkey; Yarmouk Project in Syria; Kpime Project in Togo; Grandes Chutes and Donkea Projects in Guinea; Mahbad Project in Iran; Washwang and Mondaing Project in Burma; Muda River Project in Malaysia, Kirirom Project in Cambodia and numerous other projects, among which should be mentioned the irrigation system of Ceylon for which Metalna has been supplying hundreds of gates for several years.

For many power plants in Yugoslavia and abroad, Metalna has built hitherto more than 1oo heavy power plant cranes, mostly overhead travelling cranes and gantry cranes. Large cranes of up to 1oo-ton capacity and more operate in Chichoki Mallian and Gujranwalla plants in Pakistan, Hirakud and Panchet Hill plants in India, and elsewhere. Overhead travelling cranes for handling power plant equipment weighing more than 3oo tons have been constructed for numerous power plants in Yugoslavia, among others in the Sredanja Drava I Plant constructed recently. These are not, of course, the biggest cranes

built so far by Metalna. Some years ago, the company supplied to the Gdynia Shipyard (Poland) the then largest crane on the Continent, with a capacity of 2 x 25o + 2 x 6o + 3o + 5 tons. It can handle ship sections weighing up to 5oo tons.

In addition to power plant cranes Metalna manufactures all types of hydraulic gates, ranging from the simplest emergency gates to the most intricate automatic gates with hoists, furthermore trashracks and standardized trashrack rakes, steel liners and penstocks of largest diameters. The company has equipped with penstocks as many as 79 hydroelectric power plants, the longest one, which is 6 km long, has been installed in the Kirirom hydroelectric power plant in Cambodia.

It is difficult to summarize the results of half-century's activities of the firm and the list would be too long though only the most important among the thousands of plants and units supplied in the two decades after the war would be stated. 15oo cranes and other materials handling units, 1oo,ooo tons of gates and other hydraulic equipment, 79 penstocks, 151 road, railway and combined bridges, 23o large factory buildings, sports halls and other steel framed buildings, tens of refrigerating plants and thousands of tanks, dock equipment for 11o large ships, most of which are bulk carriers of more than 1o,ooo tons TDW, have been supplied in the last two decades. A large part of this equipment has been imported in the last 12 years by 37 countries of Europe, Africa and America. These are Argentina, Austria, Brazil, Bulgaria, Burma, Ceylon, Chile, Ethiopia, East Germany, West Germany, Greece, Guinea, India, Indonesia, Iran, Israel, Jordan , Cambodia, Cuba, Liberia, Malaysia, Mexico, Norway, Pakistan, Panama, Poland, Rumania, Syria, Soviet Union, Sudan, Switzerland, Togo, Turkey and United Arab Republic.

ANNEX 2: Short Description of METALNA Works

1. Description of Factory Facilities

1.1 Survey of manufacturing facilities:

- Preparation bay
- Welded steel and aluminum structural work fabrication shops
- Hatch cover and hydraulic equipment fabrication shop
- Machine shop for machining parts required in custom-made products, with annealing department
- Machining department for production in series of parts for hydraulic gear, pumps, etc.
- Forging department
- Anticorrosive protection department

1.2 Layout of shops

The shops are provided with ample space for storing large quantities of raw materials to be fabricated. From the storage the material is given over to the preparation bay. Marking off the material is partly effected in a special area of the storage where also flame cutting can be performed. In the main, marking off, cutting to size, shearing, sawing, straightening, and machining of plate edges to be welded are performed in the preparation bay. Adjacent to that bay is the welding bay where at the rear end a press is provided for bending plates and various rolled shapes.

Adjacent to the constructional steel work and pressure vessel fabrication shop is the aluminum and aluminum-alloy tank fabrication bay. At the end of the shop is the non-destructive testing laboratory for inprocess inspection. All testing units can be carried to all shops, including the large constructional steelwork shop just behind the welding shop. Behind the large constructional steelwork shop hydraulic devices are provided for testing pressure vessels and penstock sections. Nearby a large electric annealing furnace is provided for structural work and pressure vessels.

1.3 The total area of all factory facilities is about 25,000 sq.m, and the total area covered by the factory is about 5000 sq.m.

3. Penstock and Pressure Vessels shop

The welding bay has more than 8,000 sq.m covered area. It is equipped with all required installations for electric power, compressed air and cooling water supply, and with material-handling cranes.

3. Description of Shop Equipment according to Production Process Stages

The welding bay equipment complies with the specific requirements for the fabrication of steel structures, penstocks and pressure vessels. In the main, it includes:

3.1 Plate straightening on roll machines

3.2 Marking off and cutting to size of materials - plates - is effected manually in the storage of the preparation department of the welding bay. In some cases marking off of plates is not required as cutting is effected on an automatic flame cutting unit MEGATOM according to templates.

3.3 Plate Edge Machining

Edge machining of plates and shapes to be welded can be effected as follows:

- by flame cutting with the automatic unit MEGATOM of L'AIR LIQUIDE make and manually or semi-automatically by means of other flame cutting devices;
- on plate edge planing machine of VOEST make, with 12 m long table, and on a 6 m long plate edge planing machine of VULCAN make.

3.4 Roll Bending of Plates and Shapes

Plates and shapes are roll bent:

- on a roll bending machine of BOHMERT make of 4 m effective width, for up to 40 mm plate thickness;
- on roll bending machine of KRUPP make, effective width 3.2 m, for up to 30 mm plate thickness;
- on 1,000 t capacity vertical press, for up to 100 m plate thickness.

In special cases these machines can be used for straightening of material.

4. Welding Equipment

Welding is effected manually, semi-automatically and automatically.

4.1 Manual arc welding

more than 230 welding sets of the following make ULJANIK, ELIN and BABC BOVEAR and transformers of make JUGOMONTAŽA, SIEMENS etc. are available.

4.2 Semi-automatic and automatic welding

submerged arc welding units of LINDE, WEST GERMANY, L'AIR LIQUIDE, France, ELIN, Austria, and gas shielded arc welding units (KIC, MIG) and CO_2 shielded arc welding units are used.

5. Welders

More than 250 welders yearly tested by welding institutes are employed for electric arc welding in our firm. For special structures the welders have to pass a separate qualification test so that a thorough survey of their knowledge and proficiency is given.

An accurate record is kept up to date on each welder about his proficiency.

6. Positioners

The shops are provided with positioners, part of which are power operated, used for manual arc welding as well as for automatic welding. Individual parts weighing more than 20 tons can be rotated. Large positioners for supporting-structures are also available. For instance, a post-type positioner rotating around a vertical axle up to 6 m height and with a 4 m long cantilever is employed.

7. Pressure Vessel and Penstock Section Hydraulic Testing Equipment

Devices for hydraulic testing of penstock sections up to 12 m long and up to 2,200 mm dia, and a portable hydraulic unit for testing individual penstock sections of up to 3,500 mm dia-

meter and 3,3oo mm length are provided. Likewise, pressure vessels are tested.

8. Welding Electrodes and other Filler Metal

Welding electrodes of Yugoslav and foreign makes are used for manual arc welding. The electrodes employed have been approved by authorized Classification Societies. Only basic type electrodes are used for welding pressure vessels and penstocks. For submerged arc automatic welding, welding wires and fluxes of well known makers are employed, the grade chosen depends on the quality of the base metal and requirements of the work. The filler materials are stored with particular care.

9. Annealing Equipment

9.1 Annealing Furnace

An electric annealing furnace of 1,36o kW capacity is used for stress relieving (at 64o°C) and for normalizing annealing (up to 95o°C). The furnace has been designed and constructed by Messrs. RADE KONČAR, Yugoslavia. Characteristics of furnaces are: payload: 31.5 metric tons, effective size: 3,44o x 3,84o x 15,2oo mm. The furnace is fed by its own transformer of o.1o/o.4 kV rating. It is provided with 24 measuring points for automatic recording. Accuracy of measuring: ± 1o°C.

1o. Machine Shops

The machine shops are divided into light, medium and heavy machining, and work is organized accordingly.

For heavy machining the shop is equipped with:

Heavy boring machines, 115 mm dia spindle;
Heavy lathes, 9oo - 12oo mm dia.
Machinery for medium-duty machining mainly consists of 35o mm dia lathes of length up to 3ooo mm and of planing machines.

Machinery for light machining consists of 3oo mm diameter lathes, 15oo to 2ooo long, automatic lathes, copying machines, and grinding and planing machines.

11. Organization of Inspection Department

The inspection department is directly responsible to the General Manager. The scope of the inspection department covers all inspection work in the shops as well as on the construction sites where METALMA installs the equipment it has supplied.

11.1 The inspection department consists of:

- incoming inspection section which takes over and accepts all material in the suppliers plants or in our firm;
- in-process inspection in shops where the various fabrication stages are checked with regard to the functioning of individual machine elements;
- final inspection section which effects qualitative, dimensional and functional testing of fabricated assemblies, units or plants.

11.2 Inspection department laboratories

- physical and metallographical testing laboratory;
- non-destructive testing laboratory;
- chemical laboratory;

The inspection department laboratories carry out all testing of materials regarding quality of base metal, filler metal, etc. Also research work is effected for requirements of the factory. The department keeps complete record of the materials received and of qualification tests of welders. It also keeps the inspection records on manufactured units and plants:

a) customers's name with data on plants and works orders

b) test reports and certificates or base and filler metal, data on testing in connection with welding, annealing, etc.

c) welder's qualification certificates (photostatic copies or transcriptions)

d) dimensional sketches of inspected parts on the plant, with indication of the spots inspected by radiography or ultrasound, with all required data on results, welders' designation, items and steel mill heats. Special certificates are issued for hydraulically tested items.

11.3 Laboratory equipment

a) The mechanical testing laboratory is equipped with:

- 30-ton capacity pull-test machine of AMSLER which is tested every year for the required measuring ranges
- Charpy impact-testing machine for 15 m and 30 mkp ranges for determining impact strength of materials, with cooling devices up to -60°C
- Universal apparatus for measuring HB, HRC and HV hardness and other ancillary devices for requirements of mechanical testing laboratory.

b) The metallographical laboratory is equipped for micro and macro testing of welds and metals. It is fitted with a LEITZ-PANFOTH metallographical microscope with all equipment for preparing test pieces for manual and electrical polishing.

c) The chemical laboratory effects analyses of metal, and tests paints for anticorrosive protection.

d) The non-destructive testing laboratory is provided with:

- 3 X-ray units, namely:

  300 KV X-ray unit of BALTEAU make
  300 KV X-ray unit of BALTEAU make
  300 KV X-ray unit of SR NIÖ make
- several radio-active isotope units Ir^{192}, Co^{137}
- 4 ultrasonic flaw detectors of KRAUTKRÄMER make (one of each is transisterized)
- 1 ultrasonic flaw detector of KRETZ make
- numerous sets for testing by penetration are available. They are mainly used for checking welds on high-alloyed and stainless steels and heat treatable steels.

11.4 Senior positions in the inspection department are occupied by engineers, technicians and highly-skilled inspectors.

12. Production Control and Planning Department

Production control and planning are required for correct and continuous flow of work. Therefore all designs and shop drawings go through the production control and planning department in which experts for welding, machining, heat treatment and other engineering branches work. On basis of the drawing and other required data, this department prepares the fabrication of the units or plants. It determines the correct shape of weld grooves

In relation to the welding technique, the grade of base and filler metal, the function of the welded joint or some other constructional elements in accordance with the sequence of operations of fabrication of the work from the preparation operations up to the required tests and final operational tests on the site before the plant is put into service. This department works in direct contact with the design offices, inspection department laboratories and shops.

As it can be seen from the references enclosed, for decades [redacted] has been manufacturing all kinds of units and plants with most exacting requirements. It has therefore been recognized by the Classification Societies: LLOYD'S REGISTER OF SHIPPING, JUGOSLOVENSKI REGISTER BRODOVA, BUREAU VERITAS, AMERICAN BUREAU OF SHIPPING and NORSK VERITAS.

ANNEX 3: Cranes and other Materials Handling Equipment produced by METALMA

Power plant cranes

Gantry cranes of various capacities for installing and overhauling generators, turbines and other water control equipment.

Overhead travelling cranes for hydroelectric and thermal power houses.

Draft tube gate cranes.

Gate hoists.

Steelworks cranes

Steelworks and rolling mill cranes
Pig breaking cranes
Scrap iron magnet cranes
Pig handling cranes
Casting and mixer cranes
Ladle cranes
Scrap iron container cranes
Charging cranes
Soaking pit cranes
Stripper cranes
Ingot and slab handling cranes
Tongs cranes
Lifting beam cranes
Roll replacing cranes
Cranes with beam and fork
Heat treating plant cranes
Sling handling cranes
Pouring cranes

[redacted]

Shipbuilding cranes

Portal cranes, including cranes of special design, up to highest capacities for docks or slipways.
Rotary tower cranes for slipways.
Semi-portal cranes
Hook cranes for dry docks, wet docks and floating dry docks
Floating slewing cranes with fixed or luffing jib.

Port facilities

Rotary quay cranes with hook, grab or magnet
3-ton and 5-ton capacity standard cranes.
Complete port equipment for fully mechanised unloading of ores, coal, and other bulk materials.
Handling and conveying appliances for port grain silos
Special cranes for container handling in ports, on ships, in railway stations and warehouses, made to ISO standards for containers weighing up to 30 tons
Quayside conveyors for unloading of packed goods
Standard rotary deck cranes of various capacities.

Ferrous loading and unloading facilities

For ore, coal and other bulk materials
Unloaders for ocean-going and river ships
Loaders with or without trimmers for all types of ships
Complete tanker unloading plant
Coal loading plant
Loading appliances

Transporters

with fixed bridges
with and without cantilever
with hinged jib
with movable bridge
with double rail trolley and grab
with revolving trolley
with rope-pulled trolley
with trolley and wagon tipper
with revolving crane on bridge (with hook or grab) and conveyors.

Building cranes

Rotary tower building cranes: [redacted] 14 K, LM 25 A/3e, LM 45 A/35, G 45 BW-JU and K 1806 T.

Portal cranes of light tubular construction of up to 100 m span and up to 32 ton capacity. Intended for handling prefabricated elements in building material industry.

Cableways for big projects: dams, hydroelectric power plants, bridges, etc.

Derricks.

Passenger and goods aerial ropeways

Large bicable shuttle type passenger ropeways with two cars for 80 to 100 persons each.

Large bicable continuous type passenger ropeways with 30 or more 4-passenger cabins.

Single or two-seater unmovable continuous type chair lifts with light cabins or open chairs.

Ski lifts (6 types) operated by diesel engines or electric motors with output ranging from 10 to 12 HP. Capacity up to 1,000 skiers per hour.

Goods ropeways of shuttle or continuous system.

[redacted]

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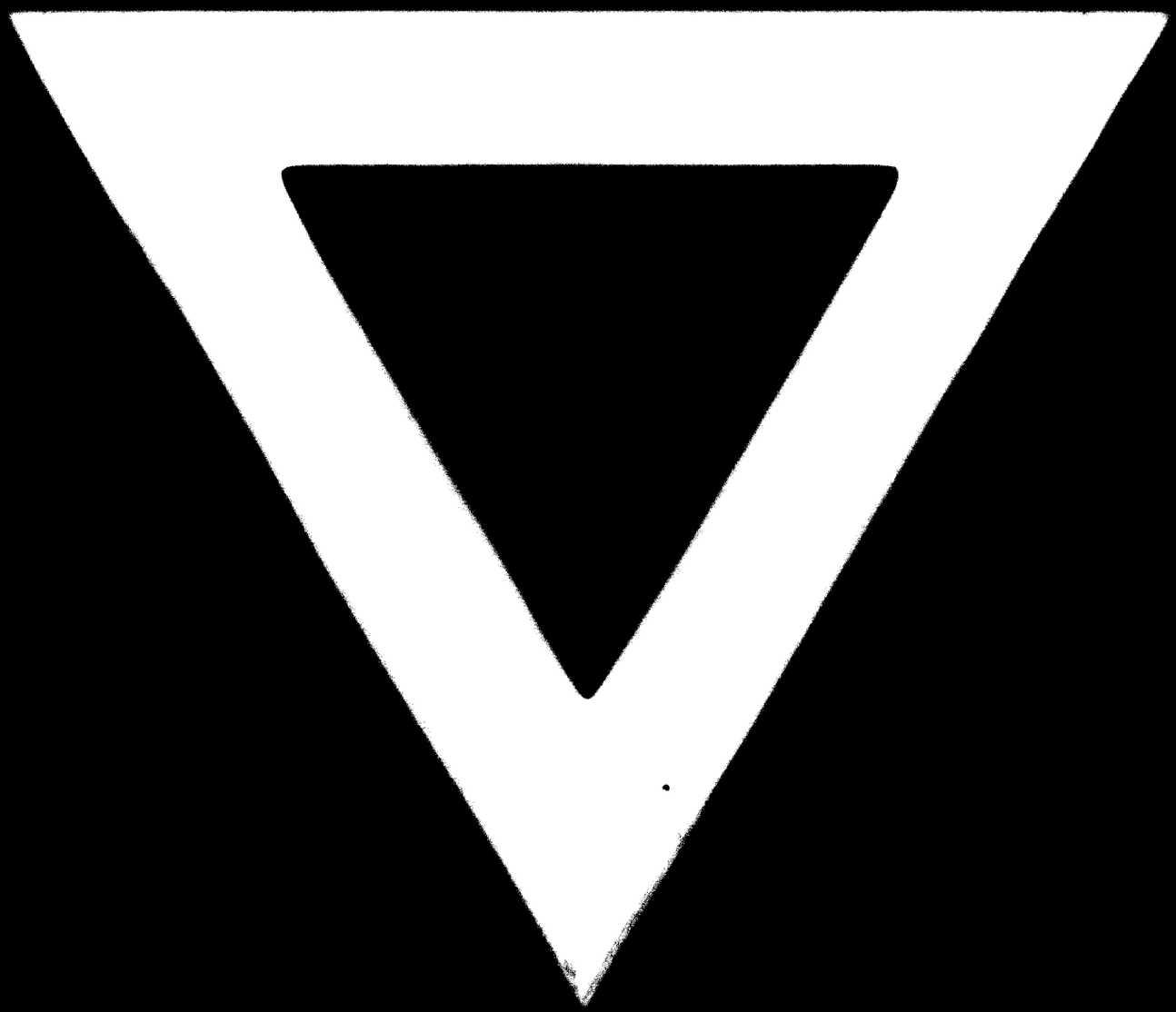

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