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PROFILE ON ESTABLISHMENT OF NATIONAL SYSTEMS FOR METAL SCRAP COLLECTION AND PROCESSING*

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INTRODUCTION

The world's natural mineral resources run out gradually. The exploitation of minerals and ores requires very much energy and live labour inputs, and thus it is increasingly expensive. In view of the energy poverty of our age, the possibility of the so-called secondary processing comes increasingly to the fore.

The developing countries - with a few exceptions - have a very poor supply of industrial raw materials and energy sources. Therefore, in such countries and also all over the world the light is increasingly focussed on the re-processing of much cheaper secondary raw materials (metal scraps).

In proportion with the development of industry and civilization, the demands for new machines, equipment and facilities are on the rise.

As a result of metal processing, the developing industry produces an increasing quantity of scraps. The higher standard of living associated with industrialization requires better motorization, household mechanization etc. These machines and equipment become obsolete after a time, they are replaced by new machines and equipment, while the obsolete or faulty units are discarded.

The scrap produced by industry and the scrap from households contain very much re-usable metal, the collection, processing and re-application of which are significantly cheaper than the production of the relevant metal from its ores. This recognition is not new, but the fact is increasingly recognized also by rich American or European countries having developed industries.

The collection and processing of scrap metals require a versatile and careful organization.

Both collection and further processing necessitate the participation of competent specialists, because this is the only way to achieve good economic results. Sorting is a complicated work, but it is worth the trouble because thus very valuable metals can be separated from not so valuable metals, and in this way not only the question of economy is solved, but also a more refined material can be further processed, which enables the production of a new, higher quality material.

If, for example an engine is disassembled and the copper components and other non-ferrous parts are removed from the cast iron block, it is not the only result that the copper which is approximately ten-times as expensive as cast iron is "saved" but also that had the copper remain in the cast iron, in the course of melting it would deteriorate the quality of cast iron, and so it could only be used for inferior purposes.

The scraps produced by industry should be stored separately already at the place and time of production, thus the mixing of various materials can be prevented, and sorting will not be necessary.

The world market price of metals keeps rising, and certain types of metals are difficult to get - even for good money - due to the fact that they are much in demand.

The use of metal scraps played an increasing role all over the world in supplying ferrous and non-ferrous metallurgy even before the so-called world market price explosion.

The role of metal scraps is even more significant in countries where the metal requirements must be met decisively through imports for the existing or developing industry, due to the endowments of these countries.

Therefore, it is in the primary economic interest of each country to re-use the metal scraps. The precondition of this is collecting the full quantity of metal scraps being and already produced.

The collection of metal scraps and the recycling of usable metals are important, necessary and socially justified tasks on the basis of environment protection, energy saving and economic reasons.

The collection and processing of metal scraps also have another, and not insignificant function. On account of the increasing production of scraps, the storing of such materials represents a great problem world-wide. At the edges of towns and settlements there are large piles of junk to demonstrate that even in countries struggling with the shortage of industrial raw material a large amount of metal scrap accumulates, which keeps increasing with motorization.

These junks not only ruin the scenery in the relevant country but also contaminate the environment and thus represent a serious problem. Metal oxides and sometimes also metals, such as lead are poisonous. If such junks are scattered and not stored properly, poisonous materials may easily leak into drinking water or they are absorbed by plants, and so through human consumption they may give rise to serious diseases.

Tourism represents a significant foreign exchange earning source for developing countries also. Consequently, it is not irrelevant that a well organized tourism cannot become profitable in a country because of car carcasses, old refrigerators and other household junks being scattered all over the place.

It is not sufficient to collect metal scraps, but they should be brought into a condition to enable industrial processing or commercial use and transport respectively.

It is not advisable for each country to make efforts about using all metals itself and about processing them into finished products. It could be imagined that through a wise and suitable division of labour, each country would make provisions for processing one metal, and through trade channels the scraps would be interchanged. In this way, a better mechanized, higher capacity and much more economic processing base could be established. And, this would be good for each country because it would be cheaper to obtain uptodate finished products on the basis of eventual commission work or simple exchange of goods.

1. CONDITIONS OF THE ECONOMIC USE OF METAL SCRAPS

The suitable metallurgical application of metal scraps and their economic utilization as a secondary raw material are not only quantitative issues. The further preconditions are primarily of qualitative character.

This is because the current high rate development of technology imposes increasing requirements on the basic materials and thus also on the products of the metallurgy of non-ferrous metals. To meet these requirements, the metallurgy of non-ferrous metals produces newer and newer metal alloys of a composition which is specified with increasingly narrow tolerances. Today, numerous standard metal alloys are produced by the metallurgical plants. The production and cutting scraps of these metal alloys and especially certain groups of such alloys which are almost identical in alloy composition, frequently show a high degree of similarity concerning the external appearance. If these metal scraps which look similar to the eyes but are of different grade alloys, get mixed up at any point of the re-application process, their separation does not only require increasing work, but also an increasing up-to-date professional knowledge.

This is because the re-application process in metallurgy is determined by two facts:

- the scraps of metals and metal alloys are usually raw materials of very high metallurgical value;
- the metal scrap batches of "mixed" grade have a very much inferior metallurgical value and they can be used only with a limited cost efficiency.

Therefore, it is understandable why advanced metallurgy imposes increasing requirements on the quality of usable metal scraps, especially concerning <u>their homogenity</u> and <u>their preparation level</u>.

Metallurgy today demands the collecting enterprises to provide not cnly homogeneous (i.e. mostly sorted) but also industrially <u>prepared</u> metal scrap batches which can be used with high efficiency and economy.

Therefore, it is very much necessary to ensure an up-to-date and professional preparation of the collected metal scraps. This process must be handled in a co-ordinated way in accordance with the requirements of metallurgical processing industries, which usually specify the processing parameters and above all the packing, baling and packaging dimensions of sorted scraps, which dimensions are important from a feeding point of view. These factors are important even if metal scraps are prepared for commercial purposes, due to the fact that the relevant country does not have provisions for metallurgical processing.

Consequently, if metal scraps are to be sold for good money, they should be well prepared in all cases. This also means that the chemical composition of sorted metal scraps is also to be determined. In the case of identical shape scraps, this is easy because sorting can be made on the basis of visual identification, but usually in such cases it is also necessary to perform random tests, requiring a laboratory and instruments.

2. ORGANIZATION CONCEPT OF METAL SCRAP COLLECTING AND PROCESSING SYSTEM

To establish the organizational system, the work processes must be known.

2.1 Classification of work processes

2.11 Collection is a process in the system, in the course of which the collecting organization of scrap processing enterprise accepts the scraps quantitatively and qualitatively at the place where they are generated, and then removes them from the site.

2.12 The industrial processing of scraps means the sorting, chopping and baling of the collected scraps in accordance with regulations. During this activity, the scraps become suitable for metallurgical or other processing.

2.13 Delivery is a process in the system, in the course of which the scrap processing organization delivers the industrially processed iron scraps made suitable for metallurgical application to the processing or user plant.

To ensure good functioning of a system, it must be centrally controlled because otherwise individual or group interests come to the fore which cannot always be co-ordinated with national interest. Therefore, the superior control system of the organization must be established on a government level. The recommended organizational configuration is shown by Fig.1.

2.2 Central collecting and processing plant

Careful consideration should be given to the geographical location of such a plant. The following factors should be taken into account:

- the role of central location,
- distance and economy from the aspect of transport,
- location of processed material user,
- eventual re-transport and export of processed material,
- long-range industrial development principles.

In countries having developed industries, the centres (because there can be many such centres) were always established near the metallurgical plants which provided further processing. Thus, material preparation may take place partly on site according to the requirements, and partly due to the proximity such technologies can be performed directly at the metallurgical plants, involving a minimal transport cost. In many cases, such plants are associated with a metallurgical processing base, and operate practically as a complementary part of that base.

PROPOSED ORGANIZATION CHART

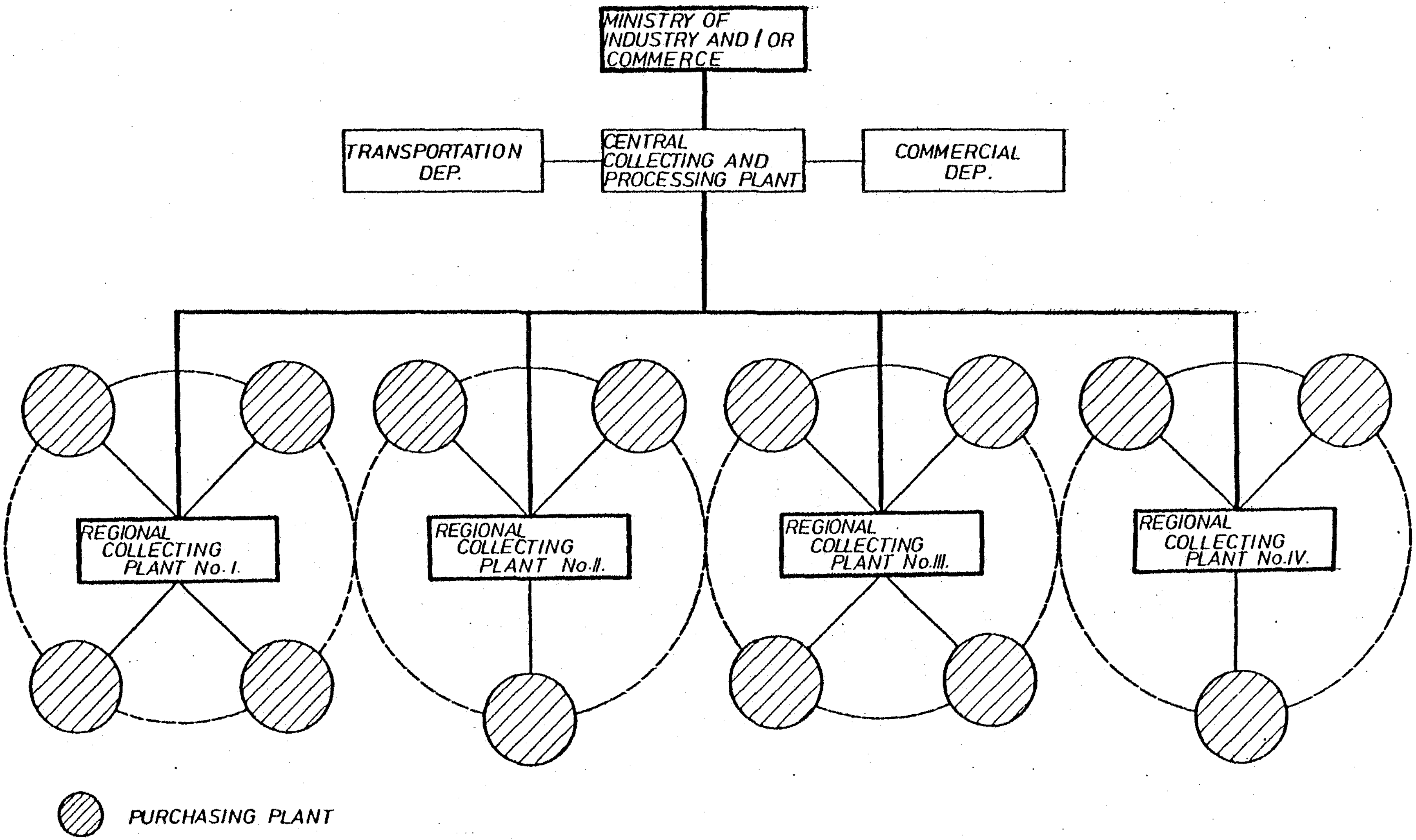


Fig. 1.

It is advisable to follow these principles in the developing countries as well, in case they have such metallurgical processing and utilization possibilities respectively.

If no such facilities are available, it is advisable to allocate a site already at this stage, which site has good transport conditions, is located at nearly identical distances from the rural collecting plants. It is also necessary that such a centre should fit into the long-range industrial development concepts so as to be integrated with them in the future.

Depending on the size of the country and on the quantity of available scraps, the number of rural and regional collecting plants is determined on the basis of economic considerations.

The collecting sites are usually located in the vicinity of an industrial town, to be well accessible by road, railway or on-water and to ensure also a significant quantity of household waste.

Such a site has an extensive collecting network, dealing exclusively with collection and purchasing. Further processing is not carried out at such sites, but cutting to size according to the delivery requirements is executed, together with storage. Each such regional site may be associated with numerous smaller collecting sites or departments which purchase metal scraps from their own small areas.

These small collecting departments store the local materials and when a suitable quantity for economic delivery is accumulated, the central collecting plant is notified and the removal of the materials is requested.

It may happen that such metal scraps are accumulated on the area of small collecting departments which raise transport problems. In this case the centre is asked for help. The centre provides special vehicles which provide for cutting to size on site and also for transport.

2.3 Scrap collecting and preparation plant

The economic solution is to transport the scraps directly to the central processing plant from an approx. 50 km area. In the case of longer distances, it is more economic to establish smaller collecting departments or to establish a scrap preparation and processing plant in such territories of the country where a large amount of scraps is produced (e.g. 10-15 thousand tons).

Of course, the equipping of such department/s with scrap processing machines is at a much lower level than that of the central processing plant.

3. ORGANIZING THE TRANSPORT OF METAL SCRAPS

One of the basic conditions of metal scraps collection is a well organized transport. Practically, the basis of the complete collection system is formed by transport. The path of scraps from the place where they are generated to the application is very long and sometimes complicated. Considering today's energy prices, efforts should be made to ensure that this path is as short as possible, i.e. it should be ensured that the transport vehicles are fully loaded on the shortest possible distances. Transporting scraps represents grave problems sometimes because the loose or large-mass scraps are very difficult to transport and loading/unloading are also complicated, consequently it is advisable to mechanize these two latter processes also.

As a first step, the regional sites should make provisions for preparing the scraps for transport.

The flow sheet of scraps transport is shown in Fig. 2.

Scraps can be classified on the basis of transport and storage, and thus the following types of scraps can be distinguished:

FLOW SHEET OF SCRAPS TRANSPORT

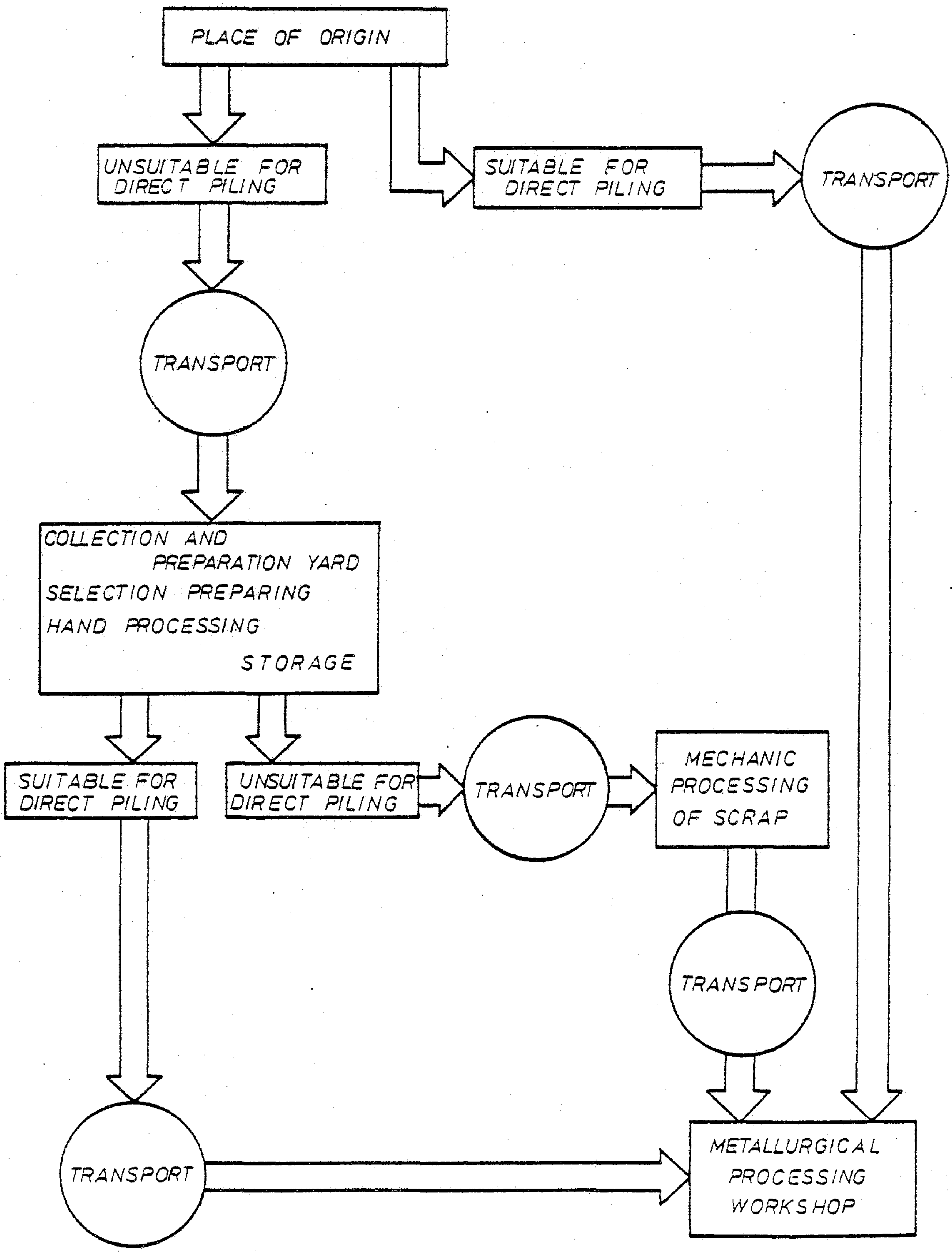


Fig. 2.

- loose sheet scraps,
- mixed sheet scraps,
- heavy scraps,
- fibrous chippings etc.

3.1 Methods of transporting metal scraps

The methods of transport are classified as follows:

3.11- Transit transport

If the scraps are generated at an enterprise which has its own industrial track or has other transport facilities, it will probably sign an agreement to supply the scraps directly to the user without using the scraps collecting place as an in-between. This is the most economic transport method and does not require transport capacity from the scraps processing enterprise. Of course, this is quite a rare case.

3.12- Transport by the supplier - the scraps supplier enterprise delivers the scraps to the collecting and processing enterprise by its own road vehicle (truck, trailer).

3.13- Transport by the processing enterprise - this is carried out by the scraps processing enterprise using its own transport vehicles and machines. In this case, the processing enterprise sends loading/unloading machine and vehicle from time to time to small industrial enterprises and craftsmen to fetch the scraps accumulated there. This transport method can be combined with railway, water or road transport, whatever is available and economic.

3.2 Road transport:

The material is transported by trucks from the supplier.

In case the processing plant lies at a distance within 30 km from the supplier, the material is to be transported directly to the processing plant while in cases of larger distances, the scraps should be transported to the next collecting site for economic reasons. In this latter case, the scraps should be transported by railway or on road with one or two loading/s, depending on the conditions prevailing at the collecting site, to the processing plant, or if the quality of the product permits to do so, directly to the user.

3.3 Loading/unloading methods

The weight of scraps and the dangerous loading (sharp, rusty etc. scraps) only rarely allow manual loading and unloading.

Again due to economic reasons, it is not advisable to have the transport vehicles waiting for long due to the slow manual loading.

The most advisable approach is to make provisions for mechanized loading and unloading.

During the first phase of collection, the collection of waste from the households, manual loading is inevitable because this work usually involves single pieces, low quantities and low weight.

However, transport to the regional plant should be mechanized. And, scraps coming from industrial enterprises can only be transported by mechanized loading and unloading, partly because of the quantity and partly because of the weight.

It is advisable to use self-loading trucks, fitted with a small crane for transport among the collection places and also when delivering to the regional site and to the processing plant. Several types of such trucks are available and they can provide for both loading and unloading.

Self-loading trucks

Usually it is not economic to use a separate loading machine for irregular or decentralized transports. In the case of such transport tasks, self-loading trucks are suitable for both piece and bulk product transport. The loading equipment is usually a swing crane.

The loading equipment of trucks fitted with swing cranes, usually having level luffing jibs of 2.5 - 4.0 m radius, is fitted between the driver's cab and the loading surface. Rotating the column of the crane, and changing the radius are ensured by a mechanical or hydraulic power transmission system operated by the truck's engine. The revolving jib can be fixed if not in use. It is advisable to organize transport in a way that a normal dumping truck and a self-loading truck fitted with crane are used, because the crane truck will first load the dump truck and then itself, thus ensuring economic loading as well as transport.

3.4 Loading/unloading of loose scraps

It is advisable to collect loose scraps into containers already at the place where they are generated or at the collecting site. The containers are then delivered to the processing plant. These unit containers can be utilized very well because they facilitate loading/unloading extremely and the materials will not be mixed up even if several materials are transported on one vehicle.

In places where a large quantity of chippings or small size and loose scraps are generated, a grab jaw type of unit should be used together with a dump truck to allow simple unloading by dumping.

3.5 Transport of large-lump scraps

Large and heavy weight scraps (railway wagons, building elements, electric power transmission line supports etc.) should be cut to size on the site by flame cutter or if there are screw joints then such items should be disassembled to a size which can be transported and loaded/unloaded, respectively.

Road vehicles are usually towed "rolling" on the road to the disassembly and processing plant.

If the weight of large scaps is so high that even after cutting to size the small crane of the truck would not be able to lift them, a large capacity four-wheel crane should be sent to the location. Such cases may occur when disassembling bridges, large structures, industrial shops for example.

3.6 Disassembly (stripping) of ships, floating and port structures

Ships can be disassembled on water or in a so-called dry dock. This requires special training and skills, as well as suitable equipment. The use of special loading equipment is also required.

4. CRITERIA OF SCRAP UTILIZATION

The factors of decisive importance in the utilization of metallurgical metal scraps are as
4.1 follows from a technical aspect:

- chemical purity,
- physical purity,
- size.

4.2 From an economic aspect:

- quantity,
- transportability,
- total costs.

The processing technology of scraps
4.3 can be divided into three sections:

- collection,
- preparation and sorting,
- utilization in the new product (this is a task of the metallurgical plant).

Practically, the processing technology determines the task of the scrap processing enterprise (plant):

- collection of scraps,
- metallurgical preparation of scraps and
- delivery of scraps to the metallurgical processing plants.

The price of prepared and sorted scraps should not be very high. Therefore, this work should be mechanized increasingly. But, mechanization is also necessary because of the quality requirements. The extent of preparation by machine depends also on the type of scraps. If a certain proportion of a collected quantity cannot be processed economically, this type of metal scrap must be sold abroad, which does not represent a difficulty on account of the increasing demands.

5. GROUPING OF SCRAPS

Scrap types can be grouped according to their main characteristics:

- the type of material and
- the place where they are produced.

5.1 Composition of metal scraps according to the type of material

As mentioned earlier, the composition of metal scraps depends on the industrial development of the country and within this of course also on the characteristics and output of the metal processing industry.

This differs from country-to-country because there is almost no single country which would be of identical industrial development and orientation as an other one, consequently this fact can only be taken into consideration generally. By the way, there is very little problem with the metal scraps produced by industry, because local skills and financial interests usually exist at the places where such scraps are produced.

Of course, this only applies to the large industrial bases, but in small and medium-scale industry many types of such scraps may be generated also the collection of which should be provided for together with the household waste.

A wide-scale organization must be established for collecting metal scraps. This organization should rely actively on the population, which plays a great role in finding and collecting such waste. The primary aim is to make the population financially interested, thus making people participate in the movement.

The only economic way is to organize a nation-wide scrap metal collection because otherwise only certain "popular" scraps are collected, which are highest in demand, while the rest is left where they are, thus contributing to the "untidy look" of the country.

5.2 Listing of metal scrap types

The scraps are classified into two main groups:

- ferrous metal scraps
- non-ferrous metal scraps.

The most frequently occurring scrap metal type, of which the largest quantity is available is the ferrous scrap listed in the first group. This type of scrap can be further divided into two large sub-groups:

- steel types,
- iron types.

Regarding the alloys, the steel types can be further divided into groups, such as:

- carbon steels or normal unalloyed structural steels,
- low alloy steels,
- high alloy steel types.

It is not really sensible to go into further grouping on a scrap level, because further sorting and classification require costly material testing equipment and high skill.

The main group of non-ferrous metals should be again further divided to several types of metals which can be sorted visually or with a simple hand-tool.

These groups are listed in the order of metals occurring most frequently and in the largest quantity:

- aluminium and its alloys,
- lead,
- copper alloys,
- zinc and tin,
- other metals.

5.3 Grouping according to the place of generation:

- Scraps of processing plants (cuttings, rejects, cutouts, chippings etc.);

- Scraps resulting from the rejection of worn-out machines and equipment (electric motors, cables, fittings, batteries etc.);
- Waste of metallurgical or chemical processes (slag, scales, slimes etc.);
- scrap metal collected from households (dishes, disassembled fittings, various articles);
- Used non-ferrous metals of military origin (infantry or artillary cases, catches, inactivated metal scraps, debris etc.);
- vehicle parts (bearings, engines, batteries etc.).

6. IRON AND STEEL SCRAPS

Metallurgical steel and iron scraps are an important and economically advantageous basic material for steelmaking. Considering their metallurgical value, steel scraps are almost as good as pig iron for steel production while the specific investment costs and operating costs of waste collection and processing are only one fifth as compared with the costs of pig iron produced from primary raw material. Moreover, the costs of transport to the site of processing per ton of steel scraps are six or eight times as low as the transport costs of charge material required to produce 1 ton of pig iron. Therefore, from the viewpoint of the national economy, the efficient separation of scrap metals of different type and quality already at the place where they are produced is extremely important.

Iron scraps include all the iron based waste that can be used in pig iron production and steelmaking, and also in the production of iron and steel castings and ferro-alloys.

6.1 Home scraps or, in other words recycle scraps obtained in the metallurgical production processes such as the scraps of metallurgical plants, steelmaking plants, rolling mills, and foundries.

The majority of such scraps is reprocessed at the place at which they are originally produced. Here they have been mentioned only to be complete.

6.2 <u>Processing and/or machining scraps</u> inherently produced in the consumption and processing of steel products. This group of scraps has a very wide range of origin including enterprises and other industrial processing organizations. Such scraps are produced during utilization of rolled and forged steel as well as steel castings by manufacturing plants, building industry, transport and communication etc.

6.3 <u>Amortization waste</u> i.e. old iron scraps that can be recovered from finished iron and steel products such as worn-out and obsolete machines, vehicles, and other iron based products that had been in use for long periods and have then been disassembled as a result of rejection or plant reconstruction.

Included within the same group are the wastes collected from households. In industrially not developed countries where not even partial processing is performed, the amount of such waste is considerable.

7. CLASSIFICATION OF IRON AND STEEL SCRAPS

The largest quantity of scrap collection and processing is represented by iron and steel scraps (and this statement applies especially to the developing countries).

The best preconditions of utilization are provided in the case of these scraps because the volume of consumption of these scraps is the highest either directly or indirectly. In almost all countries of the world this or that kind of steel or iron foundry functions. The basic material for such foundries is mostly given by scraps but there is room for significant improvement both in quantity and quality through organized collection and sorting.

In the various countries, iron and steel scraps are classified differently, depending on the waste processing technology, development level of metallurgy etc. Of course there are common features also in the various types of classification methods. For example, scraps can also be classified as follows:

- non-alloyed and alloyed scraps,
- steel scraps and cast iron scraps grouped on the basis of carbon content,
- classification on the basis of appear-

ance and quality characteristics (lumps, pressed, chippings),

- classification on the basis of the ratio of alloying elements.

Concerning the developing countries, iron and steel scraps are classified as follows:

7.1 Non-alloy steel scraps

7.11 - Heavy scraps

including rolled bars, sections, plates of a thickness over 6 mm, steel tubes of a wall thickness over 6 mm, scraps resulting from the production of locomotives and railway vehicles, forge scraps as well as the waste of other high-temperature metal processing techniques, rails, super-structure materials, railway wheel rims and bodies, malleable castings, wire ropes, and reinforcement steels of 6 to 14 mm thickness,

7.12 - miscellaneous steel scraps

including the same materials as heavy scraps but may contain scraps of a thickness under 6 mm, combined with heavy steel scraps or not detachable from them by mechanical sorting;

7.13 - loose steel scraps

including rolled bars, plates, or sections of 6 mm maximum thickness and steel tubes of 6 mm maximum wall thickness,

- loose steel scraps that can be processed by preparation,
- pressed steel scraps,
- steel chippings,
- steel and cast iron scraps recovered from slag.

7.2 Non-alloyed cast iron fragments

7.21 - fragments of machine castings

including the fragments of machines and machine parts made of cast iron etc.

7.22 - fragments of chilled castings and white iron castings

including chilled cast iron cylinders, jaw plates, railway wheels as well as the fragments of white cast iron and non-malleable white cast iron etc.,

7.23 - fragments of commercially available cast iron goods such as cast iron drain pipes, stoves, cooking plates, household facilities as well as risers, runouts etc. resulting from the casting process;

7.24 - fragments of burnt and enamelled cast iron

including burnt cast iron boilers and boiler components, grates, different burnt and enamelled containers and household facilities etc.

7.25 - cast iron scraps

resulting from the machining of cast iron products.

7.3 Cast steel scraps

7.31 - Steel lumps

including forge scraps and the waste of other high-temperature metal processing techniques as well as different rejected equipment in lumps;

7.32 - Steel cuttings

including non-chipped fibrous steel scraps containing no lumps.

7.4 Fragments of alloyed cast iron

7.41 - Cast iron lumps

including fragments of chilled cast iron mill cylinders, waste of other alloyed cast iron production processes and fragments of rejected equipment, phosphorus alloyed iron skid shoe scraps as well as fragments of other phosphorus alloyed iron castings;

7.42 - Cast iron cuttings

resulting from the machining of alloyed cast iron products.

8. NON-FERROUS METAL SCRAPS

Grouping by composition:

8.1 Copper and copper alloys:

(a) Non-clad copper wire of a diameter over 1 mm

- Non-clad copper wire of a diameter below 1 mm
- Metal-clad (e.g. tinned) copper wire
- Coated copper wire (insulated with rubber, plastic etc.),
- Copper sheet scraps (production scraps, fire-box, etc.),
- Heavy copper scraps, (tubes, bars, section castings, etc.),
- Light copper scraps (mixed copper scraps, old copper articles of a minimum 88 per cent Cu content,
- Copper cooler scraps
- Copper cuttings.

(b) - Leadless tin bronze

- Tin bronze containing lead (red alloys)
- Lead bronze
- Aluminium bronze
- Bronze sieve scraps
- Bronze cuttings

(c) - Brass sheet scraps

- Brass casting scraps
- Brass tubes, bars, wires

- Fine brass cuttings
- Fibrous brass cuttings
- Brass cooler scraps
- Brass cartridges and cases inactivated
- Light brass scraps (mixed brass scraps, old brass articles, brass fittings etc.).

(d) - Slag, slimes, fly-dust of copper metallurgy

- Shop offscourings containing copper
- Assembled machines, fittings containing copper or cooper alloy.

8.2 Aluminium and aluminium alloys:

- As-produced unalloyed iron-free aluminium sheets, strips, pipes, bars, wires,
- As-produced alloyed iron-free aluminium sheets, strips, pipes, bars, wires,
- Iron-free aluminium casting scraps
- Old iron-free aluminium or alloyed aluminium scraps,
- Iron and aluminium assembly scraps (e.g. motors, pistons)
- Aluminium cuttings,
- Aluminium slags,
- Aluminium aircraft debris

8.3 Lead and alloyed lead scraps:

- Unalloyed lead sheets, pipes, wires,
- Alloyed lead bearings, solders, shots

- Lead batteries,
- Lead slags,

8.4 <u>Tin scraps</u>

8.5 <u>Zinc scraps,</u>

8.6 <u>Nickel scraps,</u>

8.7 <u>Other metal scraps.</u>

9. THE MAIN UNITS OF THE SCRAPS PREPARATION PLANT

Essentially, the grouping of scrap metal given above suggests what has to be done. The scraps processing plant should include theee basic units such as

- Buildings and equipment of storage and handling
- Operations and equipment of industrial preparation
- Equipment of metallurgical processing.

9.1 Storage

Industrial scraps and those collected from the households should be stored upon arrival at the plant in isolation so that the next step of the preparation process (sorting, baling) can take place most economically. Each material to be stored must be examined by an explosive disposal specialist in order to prevent the storage of explosive.

Prepared and non-prepared scraps should be stored in isolation i.e. in a separate warehouse each where they can be stored in accordance with the material grouping.

The stores should be reasonably designed in a way to allow supply to and removal from the store, loading and unloading of vehicles and dump truck from both sides.

The stores should covered and they should include compartments of a size permitting to store 5 to 10 tons of material, depending on the quality of the material stored.

9.2 Scraps preparation

Scraps brought to the plant enter the so-called industrial store where they are isolated on the basis of the place of origin, to form three basic groups such as

- scraps of industrial origin (from processing plants),
- non-explosive scraps collected from households,
- explosive scraps.

Scraps falling into the first two categories can be after being tested by an explosive disposal expert, directly prepared for metallurgical processing while explosive materials should be previously classified, as follows:

- fired infantry cases (to be inactivated in heated revolving drum),
- fired artillery cases (to be inactivated by removing the catches),
- explosives that cannot be inactivated at the

plant (to be transported in accordance with the specifications to the appointed place where they are inactivated and/or exploded by qualified experts).

The next steps of the process are determined by the appearance of the materials, taking into consideration the grouping and classification given above. On the basis of appearance, the materials to be prepared are

- lump scrap metal,
- chippings.

THE MAIN STAGES OF THE SCRAP PREPARATION PROCESS ARE SHOWN IN FIG. 3

SCRAP FLOW CHART

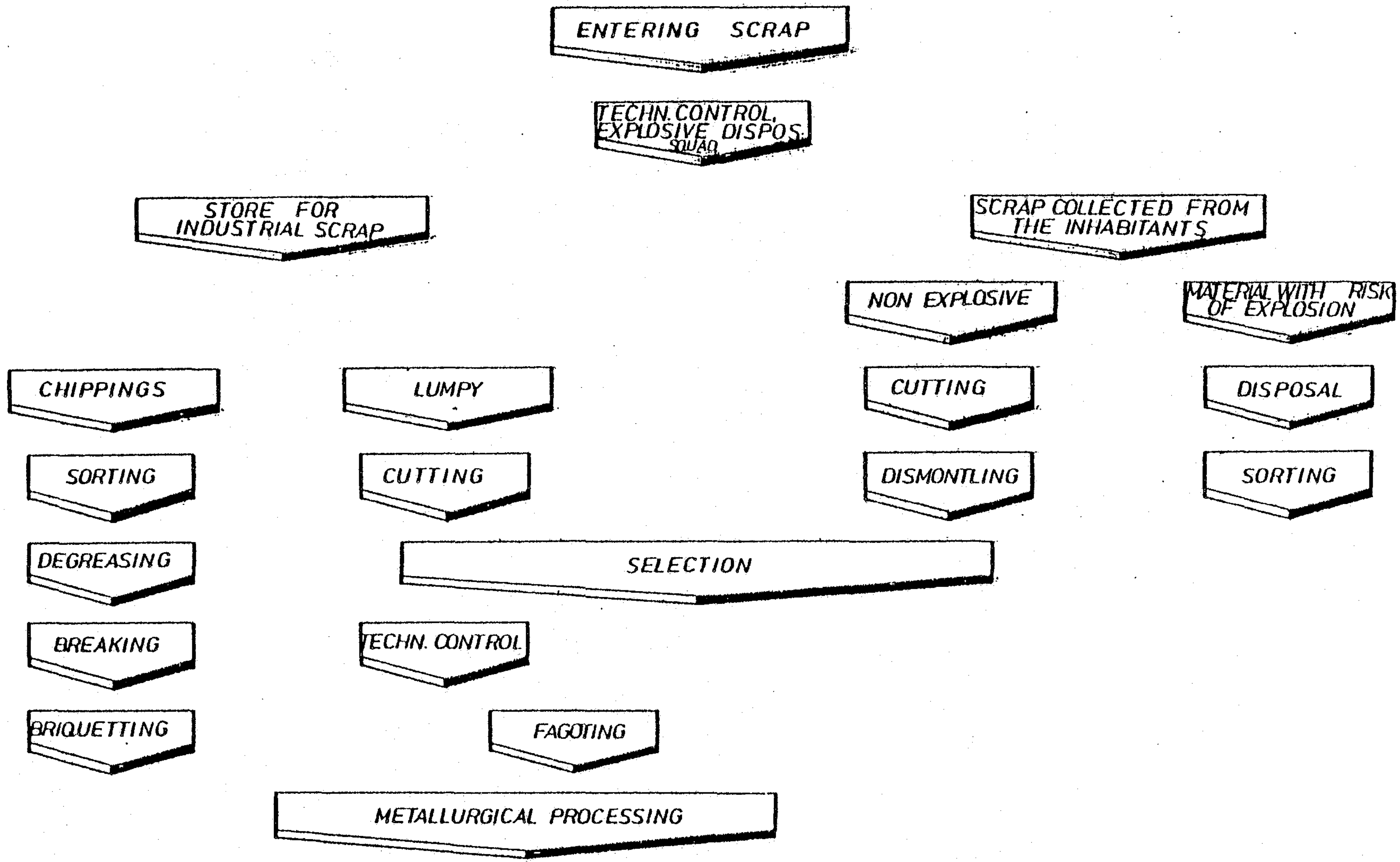


Fig. 3

1o. THE PROCESSING OF SCRAPS

The processing of scraps is a process of high significance because through this operation the value of scraps can be multiplied, therefore, it should be very well organized to ensure a sorted quality product.

In order to increase the productivity and utilization of scrap processing equipment, a continuous process consisting of three phases should be used.

1o.1 - Scraps receiving and sorting unit,

1o.2 - Processing unit,

1o.3 - Transport unit (to dispatch the finished product).

Thus, the plant installed indoors or, if the climatic conditions permit, outdoors, consists of three independent units.

The three departments are interconnected by material conveyance facilities.

In the continuous scrap processing method, the scraps are brought by truck or railway to the receiving and sorting station. Unloading takes place mechanically. The length of unloading and storage sections is identical with that of the receiving and sorting sections, ensuring fast work.

Between the point of unloading and the storage site, the scraps are sorted in accordance with the requirements of subsequent processing. Cranes are used for this purpose.

Scraps requiring additional preparation are delivered to the miscellaneous waste store.

After sorting, the scraps are taken to the processing department.

Depending on the type of scraps, processing can be

- baling,
- cutting to size,
- flame cutting,
- crushing of castings or
- chip processing.

Overhead cranes are provided for this department. A storage area is provided for each processing station to store scraps to be processed within about 5 to 7 shifts (the total plant reserves have to supply 20 shifts).

Within the scraps processing departments, scraps are delivered by special transport units or cranes to the different processing machines and they also take the finished product to the dispatching department.

Bales travel on chutes, lumps leaving the flame cutters and shears in standard containers, while the shredded chippings are taken by special trolleys and containers respectively.

The processed scraps are loaded into railway cars and trucks by cranes.

11. METAL SCRAPS SUITABLE FOR DIRECT CONSUMPTION

Recovery by smelting is not necessary in all cases for scraps resulting for certain areas of the industry. There are many such industrial scraps which can be used directly as raw material on a different processing area. This is especially frequent in the case of scraps produced in the area of sheet (plate) processing. Large cutout scraps - if produced in a large quantity - are suitable for serving as the basic material of smaller components which require a smaller piece of the plate. But, several other examples could also be mentioned from many areas of the industry.

Nowadays, there are certain industrial branches which are fully based on scraps. The companies operating in such branches conclude long-term agreements with the production plants to keep the scraps clean enough for them to purchase. There are many steel foundries which use fibrous or final scraps as charge. These scraps come from the rolling mill, but it is used as a first class charge in the foundry. Through such a secondary application (recycling) a very significant saving can be achieved.

The same statement may also apply to certain well separated items resulting from the stripping of the mixed waste collected.

For example, a first grade charge for iron foundries could be represented by certain car components such as crankcases, brake drums etc. which are made from a similar or identical grey iron all over the world, but the same applies to Al pistons for example, or to the lead components of acid-type batteries, which components are also available in a large quantity and without special preparation (cutting, baling, briquetting etc.) they can be used directly.

Further examples could be listed, but they are different in each country, because the possible fields of application determine whether the relevant scraps can be directly processed into a finished product.

12. TECHNOLOGY OF SCRAPS PREPARATION

12.1 Preparation of lump scraps

The first and most important step in the industrial preparation of scraps is sorting.

12.11 Sorting

Sorting is aimed at separating mixed scrap metal on the basis of quality.

This step of preparation is decisive for the profit of the plant.

The methods of sorting are as follows:

- visual inspection, when the scraps are sorted on the basis of external distinctive characteristics such as colour, surface of fracture, oxide colour, hardness, scratch or file scratch test, magnetizability etc.;
- drop analysis test, when the metal components are determined on the basis of the colour reaction of various chemical reagents. This method is suitable to isolate the various alloys, although it is a relatively time and labour intensive process;
- spectroscopy where the composition of the tested metal is determined on the basis of the characteristic spectral lines, or conductivity measurement using eddy-current gauge, primarily in sorting copper and non-alloy aluminium scraps.

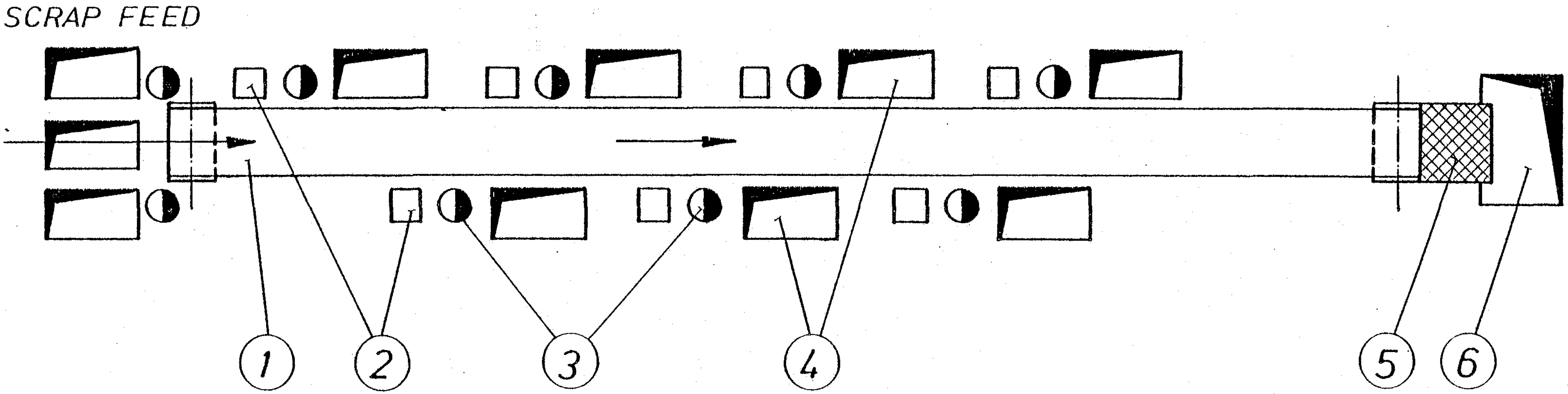
The simplest sorting method which is at the same time a very hard manual work is to isolate the different components of mixed scrap metal from one another manually by putting each inspected piece into the appropriate bin. Here the material handling cannot be significantly mechanized. A more reasonable method is using a sorting belt at a speed of about 0.04 m/sec, at which the workers are sitting or standing to sort the material brought by the conveyor. This sorting method is much more productive as there is no need for picking up each piece of material. Fig.4. From the belt, scraps of the same quality go immediately to the storage bin.

In case of a sorting belt, the material handling can be appropriately mechanized.

12.2 Cutting

- Scrap metal has to be cut to size in order to allow the charging of furnaces where the scraps have to be of 100 x 50 x 40 cm size but max. 200 kg or the charging of crucibles where the scraps have to be of 35 x 25 x 15 cm size but max. 50 kg;
- the removal of iron from scraps - e.g. an iron frame from an aluminium sheet and
- the separating of valuable scrap metal from less valuable scraps.

CONVEYER FOR SORTING OF SMALL-SIZED AND DISMANTLED SCRAPS



(1) SORTING CONVEYR

(2) BENCH

(3) WORK POSITION

(4) BOXES FOR MATERIAL STORING

(5) SCREEN

(6) STORAGE OF UNSUITABLE SCRAPS

Fig.4

For cutting, alligator shears, soft-metal cutters, flame cutters, pneumatic hammers etc. can be used.

12.3 Burning

From insulated conductors, the rubber, paper, plastic, tar, etc. coating can be removed by burning. For this purpose, the scraps are piled up on a paved surface of 10 x 10 m, diesel oil is poured onto the heap and ignited so that the coating is burnt from the wires.

The scraps so stripped are then sorted.

12.4 Baling

Loose sorted straps are baled to facilitate transport, or charging into furnaces. The bales are pressed at a pressure of minimum 350 atm.

Finished bale size: max. 400 x 250 mm in cross section, the bale length varying as a function of the amount of starting material.

12.5 Disassembly

Assemblies such as machines, petrol/diesel or electric engines, water and gas fittings, electric and telecommunication devices, vehicles, aircrafts, damaged military equipment are disassembled. Disassembly may carried out

- manually, by means of mechanical tools such as screwdriver, spanner, cold cutter, soft-metal cutter, flame cutter etc., the disassembled components being sorted subsequently.

or

- pyrometallurgically e.g. to remove babbit from bushes or lead from water fittings.

This method can be advantageously used also in the disassembly of coolers.

12.6 Preparation of chippings

Considering appearance, chippings may consist of small grains or entangled fibres, or the mixture of both. Separation of such chippings by screening is a preparation job of primary importance.

12.61 Screening

Both stationary and vibratory screens can be used for screening, removing also lumps possibly present in the chippings, and sending them for further sorting. The fibrous fraction can be baled or crushed.

12.62 Crushing of chippings

A hammer mill can be used for this purpose. Chippings have to be crushed because loose chippings are difficult to transport and to charge into the melting furnace and, on the other hand, without being crushed, loose chippings cannot be further prepared.

12.63 Degreasing

The coolant or lubricant used in machining should be separated from the chippings since oily or moist chippings cannot be deironed and such chippings can be melted in the melting furnace only at the expense of considerable burning losses. Degreasing is necessary for small-grain chippings. The methods of degreasing are as follows:

- centrifuging (using continuous or intermittently-operating centrifuge),
- chemical degreasing (using solvents to remove oil or grease from the chippings which are then dried),
- roasting (first of all for Al-cuttings).

12.64 Magnetic separation

Magnetic separation is aimed at removing iron intermingled with the non-ferrous chippings.

As a result of a magnetic field, iron chippings are separated from the non-ferrous chippings while proceeding on the conveyor belt.

12.65 Briquetting

It is advisable to briquette (compress) the chippings in order to reduce burning losses.

13. MOST IMPORTANT TECHNOLOGICAL FACILITIES OF SCRAPS PREPARATION PLANT

Depending on the type of scraps, the most significant technological facilities of preparation are as follows:

- cutting equipment,
- flame cutters,
- casting crushers,
- sorting equipment,
- baling presses,
- briquetting presses,
- special material conveyance equipment.

13.1 Cutting by alligator shears

Alligator shears range among the conventional machines of scrap processing industry.

Recently, hydraulic alligator shears have found increasing use in addition to the mechanical version. They are used to cut steel bars and plates. The most suitable type is capable of cutting steel bars up to 50 mm diameter or plates of 20 mm thickness and 200 mm width in a single cut. Hydraulic alligator shears can be controlled both manually and automatically and the cutting head can be stopped or reversed in any cutting cycle. Actuation by pedal is also possible. A disadvantage of alligator shears is that they require manual attendance.

13.2 Cutting by guillotine shears

Scraps are fed to the feed plate by means of overhead crane, the feed plate being the top plate of the ram serving for lateral compacting. Lateral compressive force amounts to about 200 tons, the compressive force applied by the cylinders to hold down and feed the scraps being about 100 tons. The cutting blade of 60 cm width is capable of carrying out 5 to 7 cuts per minute, the cutting force being 800 tons.

13.3 Flame cutting of scraps

If heavy-duty hydraulic shears are not available at the scrap processing plant, flame cutters are usually applied to cut oversize scraps such as large section beams, bars etc. Flame cutting performance is 1 to 1.2 tons/h/man in a working area of about 20 m^2/man.

13.4 Iron rail cutter

Cutting of iron rails by means of shears (alligator shears or hydraulic shears) is a highly productive but, because of the heavy wear of the blades, also a very expensive process. Because of the low productivity and high labour and material (gas and oxygen) demand, flame cutting results in poor efficiency in case of iron rails.

13.5 Crushing of castings

Castings are conventionally crushed by means of the pig breaker where, after the castings to be crushed have been fed, tups of a considerable unit mass (0.5 to 2 tons) are dropped suddenly from suitable height. This operation is repeated several times if necessary. Feed of the castings into the crushing chamber, and removal of the cast scraps from there, is mainly a manual job. Therefore, it is considered to be a rather hard work, and moreover, it also involves an accident hazard.

Performance of the pig breaker: 1 to 1.5 tons/h. A more productive crushing of castings can be achieved by means of Arnold's casting crusher developed specially for this purpose.

The casting crusher operates automatically by remote control.

The machine is fed by means of a crane or by a loading machine serving for this special purpose.

The machine requires attendance by one person.

13.6 Baling of scraps

Preparation of scraps for baling takes place in the scrap sorting department.

The preparation process consists of the following steps:

- Sorting of waste that cannot be baled using a crane for this purpose.
- Flame-cutting of oversize scraps to a size permitting baling.
- Separation of non-metallic objects.

Scraps to be baled shall be checked in respect of explosion hazard in accordance with the specifications of the relevant standard. Waste that has not been checked is considered to be explosive.

Scraps prepared for baling (scraps of sheet metal, strip steel, rolled steel section and steel tubes, tin roofing sheets, light-weight industrial and household waste, wire, structural steel, pipes etc.) are conveyed into the press chamber by means of an electromagnet or overhead crane equipped with cactus grab.

After the material has been put into the press chamber, the lid is closed, the first and final pressings are carried out, then the slide valve is opened, the bale is thrown out, and the pressing pistons are returned. The press can be actuated manually or semi-automatically.

13.7 Processing of chippings

Three basic methods are known for the processing of chippings:

- separation of fibrous and small-lump chippings in rotary sieve,
- grinding and crushing of fibrous chippings by hammer mill,
- briquetting of shredded chippings.

The chippings are suitable in each of the three cases for metallurgical processing, but the burning losses are considerable in the first case.

In order to reduce burning losses, fibrous chippings are often mixed with sheet metal scraps within the bale, followed by melting in the conventional processing method.

Small-lump chippings are fed to electric furnaces or open-hearth furnaces to be melted.

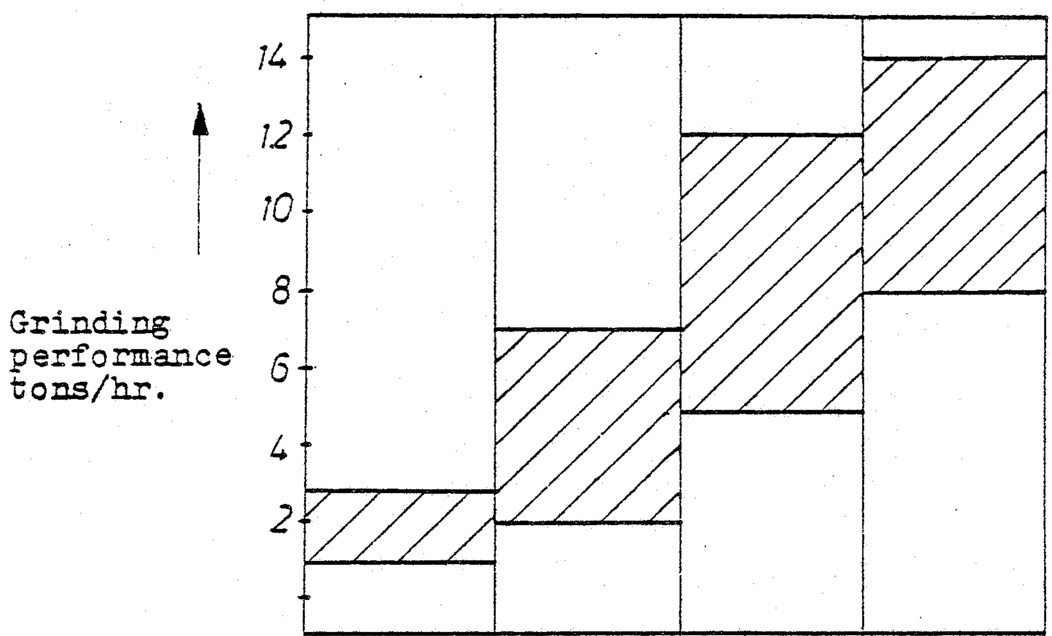
Fig. 5 describes an up-to-date method for processing the chippings.

Fibrous chippings are fed to the mill shown in the schematic layout diagram, where grinding takes place. From the mill, the shredded chippings are delivered by elevator to a rotary furnace where oil and other contaminations on the material are burnt off.

Then the chippings are briquetted. As shown by laboratory test results, the briquette characteristics including strength, bulk density and porosity, are favourable.

the main advantage of briquette is its favourable behaviour upon melt down.

Given below for the purpose of information are the performance figures of hammer crusher for the grinding of chippings as a function of the most important characteristics of hammer crusher.



Grinding chamber dia. mm	6oo-8oo	8oo-1ooo	8oo-1ooo	1ooo
width, mm	4oo-6oo	4oo-8oo	8oo-1ooo	11oo
rotations/min	1ooo-15oo	8oo-1ooo	8oo-1ooo	8oo-1ooo
mass of the machine /appr./ /in tons/	3	8	13	15
Built-in power kW	13-35	25-6o	4o-9o	8o-125

As shown by the figure, the processing of chippings is very costly, equipment-intensive and multi-stage process. Such an equipment is profitable only if a large quantity of chippings is produced in the country.

FLOW CHART OF HOT BRIQUETTING

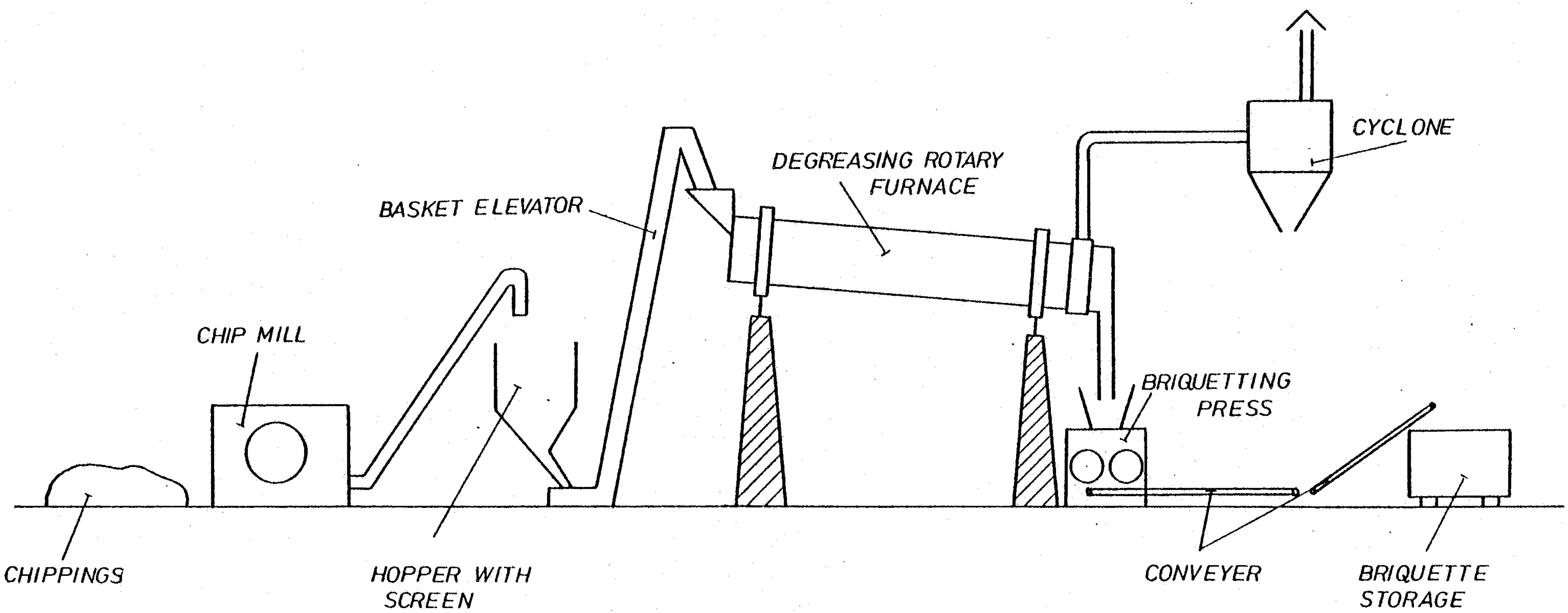


Fig. 5.

14. METALLURGICAL PROCESSING OF SCRAP METAL AND CHIPPING

14.1 Copper

Depending on the nature of the material to be processed and of the product to be produced, scrap copper can be processed in the following ways:

- by remelting
- by pyrometallurgical refining.

Remelting

Remelting can be used if sorted scraps of a composition complying with the purpose of processing are available in sufficient amounts.

Pure scrap copper and alloys of known composition are subjected to remelting.

It is general rule in remelting scraps and alloys that the finished product must not be produced in one step but blocks should always be cast first which should then be used in compliance with their composition. In remelting, care should be taken that metal oxidation, slagging, and burning losses are minimum.

For remelting, pot furnaces and electric furnaces are suitable in case smaller amounts are involved while drum-type furnaces shall be used in case the charge is large.

Pyrometallurgical refining

If the scraps contain a small amount of alloying elements or impurities which are unfavourable in respect of the alloy to be produced, such impurities shall be removed by refining in reverberatory furnace or drum-type furnace.

14.2 Scrap aluminium processing

Proper preparation in scrap aluminium processing is very important as in this way not only productivity can be increased and the economy of the process improved but preparation affects also the quality of the foundry aluminium alloys considerably.

Essentially, each type of scrap aluminium would require its own preparation method. In respect of metallurgical processing, two comprehensive groups are distinguished such as

a) Lumps including

- alloyed and unalloyed scraps
- ferrous and non-ferrous scraps
- old aluminium waste.

b) Chippings

Processing of aluminium lumps

Alloyed and unalloyed sheet and wire scraps should be baled to prepare them for melting. In this way, the burning losses can be reduced, the utilization of furnaces can be improved, a more favourable specific energy consumption can be achieved, and also transport is facilitated.

Aluminium castings are sorted into ferrous and non-ferrous castings and fed accordingly to the lower or upper chamber of the drip-furnace. Also castings of known composition should be reasonably separated. Such castings can be used for the production of foundry alloys of a narrow tolerance range.

Most problems are encountered in the preparation of old aluminium waste.

Large containers and debris can be prepared for use in furnace charge by cutting.

Ferrous and non-ferrous materials should be isolated. Non-ferrous materials can be used for the production of alloys of narrow tolerances while ferrous materials can be processed in drip-furnaces to obtain alloys exposed to moderate loads in use.

14.21 <u>Processing of aluminium chippings</u>

In respect of processing, aluminium chippings are grouped as fibrous and small-grained chippings.

Fibrous chippings can be melted either directly, or, after baling, in bales in a salt bath.

Small-grained chippings are dried in finned drum-type furnaces where oil, moisture, and organic impurities are removed directly by firing. From the drier, the chippings are fed into the magnetic separator where iron chippings are separated from aluminium as a result of a magnetic field. The particles below 2 mm shall be removed by screening in order to avoid explosion.

The chippings se prepared are then melted in a salt bath into blocks.

14.22 Block production

The size of the block is determined by the furnace or crucible capacity of the foundries where the blocks are used. The unit block weight ranges in general between 4 and 25 kg. In order to facilitate cutting, the blocks are produced in simple, double, quadruple and ten-compartment casting moulds. To facilitate removal of the blocks from the moulds, the moulds are either conic or have rounded edges. Their internal surfaces should be coated with kaolin, calcined bones, boric acid, or graphite water. Blocks to be transported are tied with steel strips to keep them together.

15. THE PRICE RANGE OF CERTAIN TYPES OF SCRAPS AND THE EXTRA PROFIT TO BE ACHIEVED BY SORTING

Sorting plays an especially significant role in the case of expensive metal alloys. Of course it cannot be neglected in the case of iron and steel types either, because as related to the basic price a significant profit is also obtained here, which adequately covers the machine and labour inputs.

The following discussion shows the price of some non-ferrous metal types and the percentage of extra profit to be obtained by sorting.

Taking the 1982 world market prices into consideration, the profitability of sorting can be illustrated by the following examples:

Price of mixed copper scraps: 940 to 110 $/ton
Price of mixed copper wires: 1110 to 1245$/ton
Price of bright copper wires: 1370 to 1480$/ton.

Sorting of mixed copper scraps results in an average increase of <u>24 % in value</u>.

Price of mixed brass scraps: 665 to 817 $/ton
Price of brass casting scraps: 700 to 880 $/ton
Price of brass sheet scraps: 1025 to 1770 $/ton

Sorting of mixed brass scraps results in an average increase of <u>28 % in value</u>.

The price of bronze scraps ranges between 1370 and 1770 $/ton, depending on the Sn content.

Assuming mixed copper and copper alloy scraps the price of which has been assumed at the lowest price of brass, sorted so as to obtain copper, bronze, and brass, the increase in value will be 40 to 60 %.

Of course, the increase of value always depends on the composition of mixed scraps and on the efficiency of sorting.

Assuming also 1982 prices for aluminium, the sorting of aluminium scraps may result in an increase of 24 % in value on the average.

Hence, an overall increase of 20 to 40% in value can be achieved by sorting of mixed scraps.

These examples demonstrate that already at the place where they are generated, it is worth giving better attention to scraps because if they are not mixed, the work phase of sorting can be saved.

16. QUALITY CONTROL

Quality control is necessary throughout the scraps preparation and processing. The first step of quality control is acceptance of the scraps when the quality (and at the same time the price) of the material supplied has to be determined. Responsibility for this activity lies with the external acceptance staff. In the course of industrial preparation, compliance of the preparation process with the specifications should be checked. This is called inter-production control. After completion of industrial preparation and metallurgical processing, the finished products should be checked by the finished products acceptance staff.

16.1 - External acceptance

Here the scraps brought to the plant are visually inspected or samples are removed from them to determine the quality of and the impurities in the material. In case of visual inspection, the quality is determined on the basis of external distinctive characteristics (colour, oxide colour, surface of fracture, hardness, shape, size etc.). If reliable results are not obtained by visual inspection, samples are removed from the material and tested in laboratory.

16.2 - Inter-production control

The inter-production control staff check in the course of preparation whether the different steps of preparation are carried out correctly. Check-up is extended to sorting by quality, compliance with the specified size in cutting, avoiding the mixing-up of different type and quality materials. Samples are removed at random from the prepared material for testing. The inter-production control staff is entitled to have the work process repeated if found to be unsatisfactory.

16.3 - Finished products acceptance

Except for materials the quality of which can be unambiguously determined on the basis of external distinctive characteristics, each material is accepted on the basis of laboratory testing of samples. The laboratory tests include chemical or spectral analysis. The finished products acceptance staff issues quality certificate for the finished products. The certificate covers the warranted values in case of prepared scraps and the percentage of the required components in case of blocks produced metallurgically.

17. QUALITY CONTROL

SPECIFICATIONS CONCERNING THE ACCEPTANCE OF METAL SCRAPS

Considering the large amounts of material involved, the material to be processed should be fed directly into the appropriate storage bin from the railway car, or truck. Upon filling the storage bins, the steel scraps must be checked for explosion hazard.

One of the most important quality figures of iron scraps is the type of impurities present in them. Distinction is made by the specification (formulated by the Ministry of Industry, Planning Board or Standards Institution of the relevant country) between dangerous and harmless contaminants of which the presence of dangerous contaminants is inadmissible while a limited amount of harmless contaminants is permitted by the standard.

Ammunition, pyrotechnical materials, enclosed glass bodies, steel cylinder as well as such chemicals and such an amount of moisture that may result in explosion in the course of metallurgical preparation and processing must not be present in the metal scraps and fragments of castings, nor the presence of chemicals of a concentration harmful to human health is permitted.

The absence of explosives in the shipment must be checked by an explosive disposal specialist, and a certificate confirming that the material is free of any explosive must be attached to the shipment. Producers the production activity of which a priori excludes the presence of explosives in the waste supplied may certify without the contribution of an explosive disposal specialist, that there is no explosive present in the material.

Harmless contaminants:	moisture, snow
	wood
	earth, sand, cement
	rags (in limited amount)

17.1 Handling of inflammable, poisonous and explosive scraps

- Inflammable scraps are those which include inflammable materials. Due to their inflammable nature, they must be stored separately from the other scraps. It is prohibited to cut these scraps to size by flame-cutters or revolving disk cutters.

17.2 - Poisonous scraps

These are tubes, machines, vessels etc, contaminated by or including various chemicals. Venicle batteries discarded in large quantities recently also fall into this category, because their acid content is hazardous to health.

17.3 - Explosive scraps

All scraps must be checked during collection or upon arrival to the plant, before they are sent to the store or to the processing department.

Explosive scraps must be inspected by a trained explosive disposal specialist, who will perform inactivation if necessary.

Special regulations must be formulated on the treatment of dangerous scraps and all employees must receive information on these regulations.

18. STORING OF SCRAPS

Before and after sorting, the collected scraps must be stored to ensure the availability of a suitable quantity for processing or delivery.

The function of the store is basically the "balancing" of time, i.e. storage for longer or shorter periods, which is associated mostly with a secondary task: the arranging of scraps. In most of the cases, the scraps are also subjected to quantitative and qualitative inspection, and various administration activities are also carried out. The aim is usually to maintain (preserve) the characteristics of the stored scraps.

Concerning the period, the storage can be prolonged (approx. 1 year), temporary (a few weeks or a few months) or short (a few days or one week). In certain cases the function of the store is limited to the secondary activities (e.g. arrangement, inspection, administration etc.).

In such a case it may happen that the scraps are stored in the warehouse for a period shorter than one day, while special reserving and keeping tasks may necessitate storage for several years.

It may also be the function of the store to arrange the scraps. There are three basic methods for "arranging" the scraps: collection, distribution and the so-called "forming of commission". (In practice, these categories rarely appear alone).

18.1 Open-air storage

Open-air storing areas.

A significant part of scraps in bulk does not require special protection against weather. Such scraps can be stored in open air, without building or roof structure.

In this case, storage is carried out on a flat area using various technologies which are mechanized to the required extent. There are some facilities which must be provided for open-air storing areas partly for protecting the quality of materials stored there and partly for enabling the operation of material conveyance equipment applied, etc.

In most cases it is required to pave the storing area.

When using installed material conveyance machines and cranes, pavement may not be necessary but the top layer of soil is not firm enough in most cases, so it is generally required to replace, compact or improve this layer. When operating mobile machines, this is usually insufficient and the use of a solid pavement is necessary with a capacity to hold the moving machines in addition to the weight of the stored material.

Finding a suitable method for drainage is indispensable for open-air storage areas. In the case of an unsuitable drainage the area becomes muddy and thus unsuitable for storage.

Pavement, road system for material conveyance operations serving the storing of scraps is necessary to enable safe movement of labour and the material conveyance machines, regardless of weather conditions. Roads with pavement of suitable strength should be established even if the scraps are placed on natural ar improved quality soil. This requirement also applies to a storage area where crane is fitted.

At variance with the open-air stores having a road network, a fully paved storing area is a higher quality solution ensuring better handling.

Since the arrival and loading of vehicles can rarely be co-ordinated perfectly, generally provision should be made for ensuring the weighing and temporary storing of vehicles. A similar temporary storage requirement may be imposed by almost any element of the activities at the store.

18.2 Covered stores and warehouses.

It is advisable to store certain types of scraps and mainly the industrial sterile scraps in a covered warehouse, to avoid oxidization.

For this purpose, simple stores consisting of a light roof structure on columns are used, enabling easy access from all sides, to ensure easy and rapid supply to and removal from the store.

18.3 Storage within the warehouse

To store scraps in bulk in the store, it is advisable to make compartments which prevent the mix-up of the materials.

To store more valuable scraps in low quantity, mobile and module storing containers are applied which are also used in transporting the scraps between the plant and other plants, and to the processing department respectively. Containers can be used very economically for storage because they can be stacked.

Of the transport and storage boxes, most significant are the module-system boxes made of steel or aluminium plates.

The transport bins suitable for delivering bulk materials are usually designed to be completely enclosed.

<u>Dimensions and volume of Tote-system transport bins</u>

Type	Dimensions (mm)										Volume
	A	B	C	D	E	F	G	H	J	K	m^3
A42	1070	1224	1143	1080	533	914	114	883	44	851	1.3
A74	1070	1224	1822	1759	533	914	114	883	44	851	2.2
A95	1070	1224	2270	2207	533	914	114	883	44	851	2.8
A110	1070	1224	2562	2499	533	914	114	883	44	851	3.1

*****

The loading and unloading time of container transport is very short, consequently this method is economic. The unit containers are owned by the scraps processing plant, on an exchange basis.

19. MATERIAL CONVEYANCE FACILITIES WITHIN THE PLANT AND STORE

As mentioned earlier, material conveyance is a process of very high significance in the scrap processing industry. The material conveyance and in-plant transport should be mechanized to the required extent. For this purpose, numerous types of forklifts and other purpose-oriented carrier, stacker and hoisting vehicles have been developed. (Material conveyance by truck is not mentioned here because a truck is not suitable for moving indoors.)

Forklifts are very mobile and easy to handle, so in the case of container or pallet storage this can be considered to be the only economic solution. This is the method which has gained the widest application all over the world.

Power driven forklifts

Characteristics

Power driven forklifts are among the most important equipment for material conveyance within the plant, warehouse and storing site .They can be easily regrouped, their mobility is almost limitless and they are suitable for conveying both piece and bulk materials.

Classification. Regarding the power source, combined operation, electric motor and internal combustion motor forklifts are distinguished.

Trolleys

The trolleys are of three or four wheel design, so they keep the load balanced even without human intervention. The loading capacity of a trolley is 600-1000 kg and the deadweight is 150-200 kg. Usually they have a flat loading surface but may also be fittəd with various accessories (stanchions, sidewalls, front-walls etc.) according to the field of application.

Manual facilities of pallet-type material conveyance

For moving pallet-type unit loads it is most advisable to apply power-driven forklifts. In case the local characteristics (narrow aisle, low floor capacity, thin traffic etc.) do not enable the application of power-driven forklifts, the pallet-type unit loads can also be moved by manual forklifts or manual stackers.

It is a characteristic of manual forklifts that the centre of gravity of the load is within the support polygon formed by the steered wheels and the support rollers at the ends of the fork branches. Certain types are fitted with so-called run-up rollers of smaller diameter be- fore and after the fork-rollers serving as wheels, and these run-up rollers facilitate the overcoming of small obstacles.

Well applicable for the in-plant trans- port of large weight and single pieces are the cranes. Using an overhead crane or frame crane over the material storing area ensures a very rapid transport. The truck stops under the crane, then the crane removes the bales or certain large weight pieces, taking them to the storage area. The crane can then remove the scraps any time from the sto- rage area, loading them on the next transport ve- hicle or taking them to the area where cutting to size is carried out.

2o. CHARACTERISTIC DATA, DIMENSIONS AND COST ESTIMATE OF SCRAPS COLLECTING AND PREPARATION PLANT

Area

For a plant processing
30 - 50,000 tons/year of iron and steel scraps as well as
10 - 20,000 tons/year of non-ferrous scraps,
the estimated area requirement is

200 x 400 m (approx. 80,000 m^2).

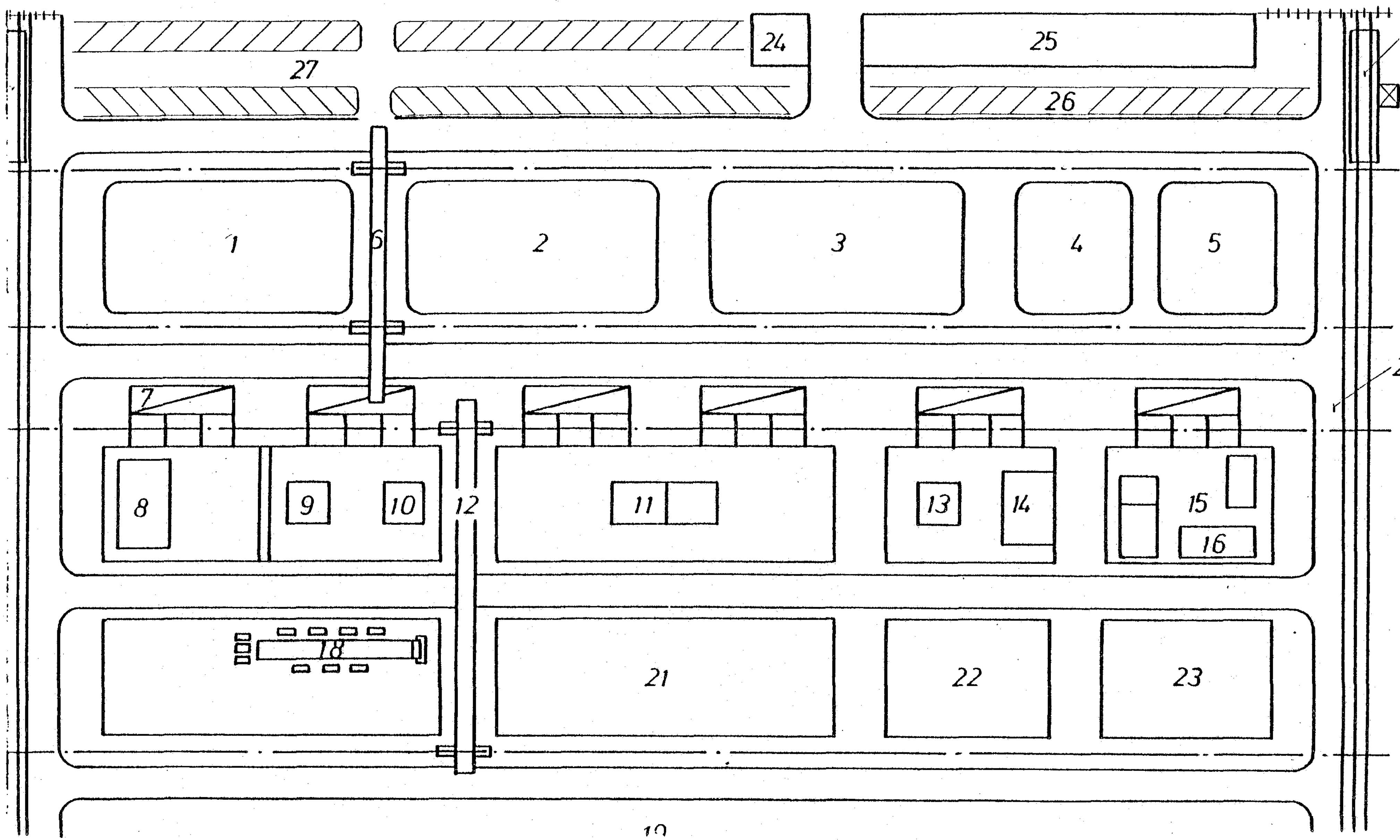
Most of this area should be provided with concrete surface and solid pavement, and if possible industrial track should be available.

The complete system is located on this area:

- Office and amenity buildings (dressing room, bathroom, dining room etc.)
- stores,
- vehicle area
- processing technology shop,
- maintenance department,
- workshop for explosive disposal personnel,
- open-air stores.

The recommended schematic layout is shown in Fig. 6 . The layout of the plant should be designed carefully, taking into consideration

ARRANGEMENT PLAN FOR PLANT, PROCESSING FERROUS AND NON-FERROUS SCRAP



1. Storage for heavy scrap
2. Storage for mixed scrap
3. Storage for non-ferrous metal
4. Storage for castings
5. Storage for chippings
6. Frame crane
7. Chutes
8. Cutting torches
9. Alligator shears, big
10. Alligator shears, small
11. Baling press
12. Bridge crane
13. Castings crusher
14. Storage place for castings
15. Chippings processing machine-line
16. Storage place for briquettes
17. Bridge scale
18. Sorting conveyer
19. Open air storage area
20. In-plant system
21. Blocking /melting/
22. Storage place for processed scrap
24. Porter's lodge and checking of delivery sheets
25. Office building
26. Parking lot for cars
27. Parking lot for trucks

the high material flow and the good accessibility of stores and loading/unloading sites.

The buildings should be designed to make maximum use of local materials, and in our opinion light structure is a must.

m^2	Denomination	Price estimate/m^2	Total
800 m^2	Office building with transformer and boiler rooms	800 $/$m^2$	64,000
500 m^2	Maintenance workshop	260 $/$m^2$	13,000
30 m^2	Explosive disposal workshop	260 $/$m^2$	48,000
2200 m^2	Industrial processing shop	400 $/$m^2$	880,000
3000 m^2	Open-air scraps store	100 $/$m^2$	300,000
2000 m^2	Finished product	100 $/$m^2$	200,000
		Total:	1,998,000

Consequently, construction can be covered by approx. US $ 2,2 million, including maximum use of local materials as mentioned earlier.

The additional costs arising from the building of the fence, concrete surface, rain drainage, lighting and the price of the land itself can be covered by approx. US $ 800,000-1,000,000

CENTRAL COLLECTING AND PROCESSING BASE

MANPOWER REQUIREMENT OF MANAGEMENT AND

OTHER EMPLOYEES

	Qualified	Administrative	Skilled workers	Semi-skilled ws.	Unskilled workers	Total
General manager	1	-	-	-	-	1
Commercial director	1	-	-	-	-	1
CHIEF engineer	1	-	-	-	-	1
Chief accountant	1	-	-	-	-	1
Production manager	1	-	-	-	-	1
Secretariat	-	2	1	-	1	4
Security Guard	-	-	1	10	-	11
Personal department	-	1	-	1	-	2
Export-Import	2	2	-	-	-	4
Local market	-	1	3	-	-	4
Transport officer	-	4	2	-	-	6
Transport Dep.	-	-	10	10	-	20
Vehicles Maintenance	-	1	15	5	-	16
Packing Dep.	-	-	16	5	5	20
Programme Dep.	-	4	-	2	-	6
Accountants	-	2	-	2	-	4
Book keeper	-	2	-	2	-	4

Cashier	-	1	-	-	-	1
Technologies	1	1	3	2	-	7
Scraps processing	-	1	10	5	10	26
Explosive disposal personnel	-	-	2	-	2	4
Power engineering specialist	1	1	-	-	-	2
Gen.maintenance	1	1	4	4	4	14
Quality control	1	1	2	-	1	5
Training dep.	2	1	6	-	-	9
Total:	13	26	75	48	23	185

*****

This table does not include the labour requirement of regional sites. This will be determined according to the area, the quantity of scraps and the turnover.

The smallest such unit consists of four persons:

- plant manager,
- cashier accountant,
- two helpers.

The staff of collecting places must adjust flexibly to the requirement. The plant manager may request specialists from the centre if required, while helpers can be employed at his option on a contractual basis.

For the recommended organizational chart see Fig.7.

PROPOSED ORGANIZATION CHART FOR ACTIVITIES

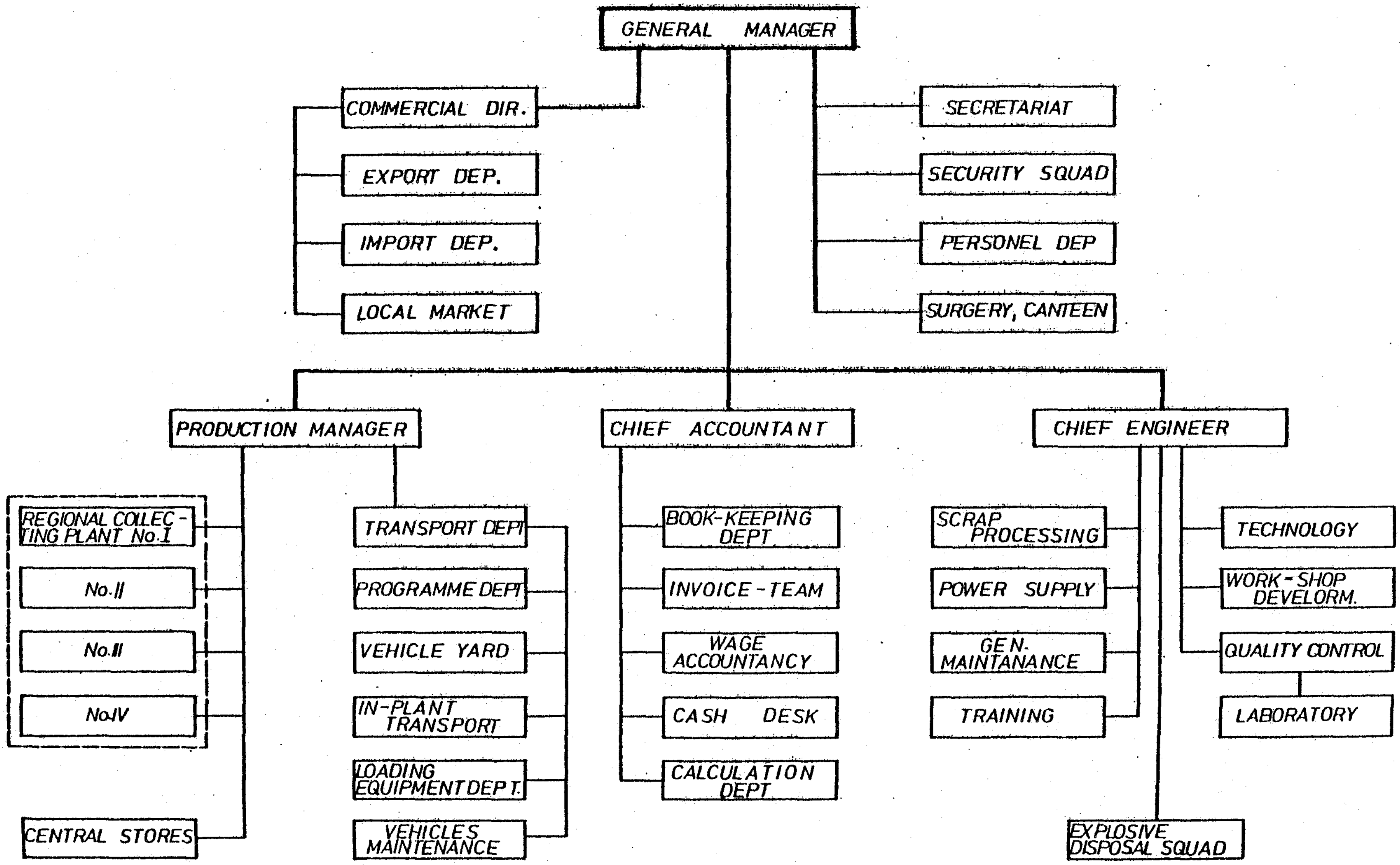


Fig.7.

22. LISTING AND PRICE ESTIMATE OF MACHINES AND EQUIPMENT FOR CENTRAL PLANT

Prices have been calculated on the basis of 1982 purchasing prices, according to the quotations and leaflets received from the producers.

- Machines - equipment - tools

Qty	Denomination	US $ 1000 price/pc	total
5	Flame cutters	1	5
2	Alligator shears	30	60
1	Baling press	430	430
1	Baling press, mobile	143	143
1	Rotary drum type sieve	6	6
1	Equipment for grinding the chippings	57	57
1	Rotary-drum type furnace	24	24
1	Briquette compressing machine	150	150
1	Casting crusher	30	30
2	Weigh bridges 30 tons	6	12
1	Sorting belt 20 m	15	15
2	Transport belts	5	5
2	Air compressors, mobile	7	14
1	Magnetic separator	17	17
-	Small machines for manual use	10	10
-	Hand tools	5	5

Qty	Denomination	US $ 1000 price pc	total
-	Personal protective devices	12	12
-	Miscellaneous	10	10
2	Crucible-type 200 kg melting furnaces	15	30
2	Series-type block moulds	5	10
2	Casting ladles	1	2
-	Auxiliary facilities for casting	8	8
-	Air exhaust fans	10	10
	Total:		1070

Transport, loading/unloading and storing units

Qty	Denomination	US $ 1000 price/pc	total
1	Frame crane	140	140
1	Overhead crane	80	80
2	Loading machines with rubber tyres	29	58
1	Revolving loading machine	30	30
4	Diesel or electric forklifts	10	40
4	Self-loading trucks	15	60
10	Trolleys	0.5	5
4	Hoist-type trolleys	1	4
2	Chain-type hoist, manual	1	2
200	Storing boxes		25
500	Pallets		10
2	Bunching-banding machines	3	6
	Total:		460

The list does not include the transport facilities of regional collecting plants which should be acquired according to local requirements

Material testing instruments

	US $ 100
2 spectroscopes	20
Auxiliary hand tools	10
Total:	US $ 30,000

23. Investment costs of central scraps collecting and processing plant

Calculated at 1982 prices, the costs of the main units at the scraps collecting and processing plant of described capacity and construction are as follows:

Denomination	US $ 1000
Construction costs	2,200
Processing machines and equipment	1,070
Test instruments	30
Transport facilities	460
Road network within plant	100
Security and fire fighting equipment	50
Utilities within plant	120
Grand total:	4,030

The sum above does not include the cost of the land required for establishing the plant

This cannot even be estimated because land has a different price in each country, but even within one country there may be very large differences of several magnitudes depending on the location.

On the basis of surveying the local requirements and possibilities, the investment can be implemented in several phases, but in that case carefully prepared, long-term plans must be made, and the implementation of one phase must not be prevented by the finishing of another phase.

24. POWER REQUIREMENT OF THE SCRAPS COLLECTING AND PROCESSING PLANT

24.1 - Electric power

The machines and equipment of the plant are usually of electric operation. They require the following electric power approximately:

Built-in output	380 kW
Simultaneous peak	200 kW

These figures exclude the lighting outdoors and the direct lighting for workplaces, which require an energy of approx. 50 kW.

24.2 Industrial water

Volume (average)	0.2 m^3/hour

24.3 Fuel oil

For operation of melting furnace and revolving -drum furnace

the heat value required is 9000 cal/kg

Average: 50 litre/hour

This figure excludes the fuel of vehicles, which can only be estimated according to local experience.

25. PERSONAL PRECONDITIONS OF COLLECTING AND PROCESSING SCRAPS

As demonstrated by the list of personnel, successful operation requires some skilled and several semi-skilled workers, to be trained partly at the already operating foreign plants and partly on site with the participation of UN experts.

Training on the operation of machines and equipment is usually the sub-contractor's responsibility and this task is usually carried out by the specialists of the company supplying the relevant machine.

Technical assistance by UN Experts

42 man-months

Fellowship (training overseas)

80 man-months

Technical and managerial assistance

Assistance for:

- Project co-ordinator
- Management
- Supervision by UN experts.

24 man-months

This man-month requirement excludes the preparation of preliminary studies before the starting of the project and it does not cover the work of consultants required for designing the plant.

The training of various vehicle drivers was not considered either, based on the assumption that such trained drivers can be found in each country or they can be trained within the framework of local driving courses.

26. CONCLUSIONS AND RECOMMENDATION

A complete scraps collecting and processing system has been elaborated on the basis of the long experience of industrially developed countries. This system and mechanization are based on a cost-effective system in which the collection and generation of scraps can be kept at a relatively identical level.

- The collection and processing of ferrous and non-ferrous metals are carried out within one system in one plant in view of the fact that the utilization level of expensive machines and equipment must be increased, thus improving the economy of the whole system.
- Scraps are really good value today and so it must be managed sensibly and reasonably. The main efforts should be directed at meeting the local requirements and thorough consideration should be given to what is sold, in which quantity and for what price. Utmost attention should be given to long-range development so as prevent the selling of future raw material basis for an industrial project to be implemented.
- Of course, the system and processing base described must not be interpreted as a firm unchangeable concept because each country has its own and specific endowments and possibilities

to which the development must be adapted.

- As an advise, it may also be said that before establishing and developing a scrap utilization system, a wide-range survey must be made to enable elaborating all details of the development.
- Recycling is a well recognized and in fact urgent need today, which has very large reserves in the developing countries and opens up vast possibilities in all walks of life.

27. COMMENTS

- This study only deals with the collection and processing of metallic scraps involved in metallurgical processing.
- The processing of scrap metals is only dealt with up to the stage when the scraps are charged.
- Naturally, during collecting and processing respectively, through careful organization and sorting, valuable basic materials can be provided directly for engineering industry processing (bypassing the metallurgical processing stage).
- This activity is significant also from the standpoint that certain machine components can be re-used after careful disassembly (due to the fact that not all components are useless in a worn-out equipment or machine). These components can be re-used as spares. This especially applies to the large vehicle industry.
- This study did not aim at discussing the collecting and processing of other industrial and household waste (e.g. rubber, textile, paper, glass, plastic etc.) but we would like to call attention to this field, as a territory again opening up huge possibilities.