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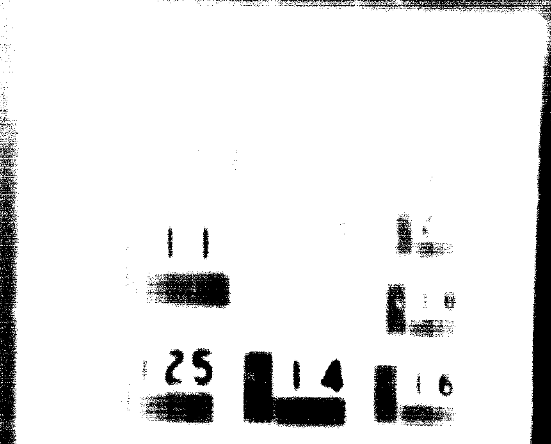

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POSSIBILITIES OF ESTABLISHING TELECOMMUNICATION INDUSTRY AND PLANNING OF THE SAME WITH SPECIAL REFERENCE TO DEVELOPING COUNTRIES[1]

by

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SUPPLEMENTS:

I. POLITICAL, ECONOMIC AND TECHNOLOGICAL PREREQUISITES OF MANUFACTURING TELECOMMUNICATION EQUIPMENTS

Political and economic relations

A typical feature of the economic development of our age is the ever growing contribution of industry to the economic expansion. A natural result of this tendency is that the developing countries, in order to accelerate their industrial growth, are striving to increase the percentage of the industrial investments within the structure of their national economy. Already their systematic economic actions, in order to increase considerably the rate of their earlier established economic development lead in any case to the loss of the social, economic and political balance prevailing in the past. The unbalance for a short period has no negative effect on the national economy, provided in a long run the balance becomes reestablished and results in an economic structure of higher level. As a matter of these considerations it follows that, from the point of view of economic development, the economic objectives mean optimum possibility, but, if there are urgent needs, time may be the crucial factor. This latter alternative of the possible economic actions is to be followed if there is a great risk of preserving unbalance for a too long period. The social, economic and political consequences of the economic actions should, therefore, be evaluated and scrutinized not only in a short but also in a long run, in order to avoid any unreasonable use of resources of which there is anyhow a lack in these national economies.

It follows, that the governments, forming the economic policy, particularly in developing countries, cannot occupy a "laissez faire" position, since the results of economic actions will, in the long run, react on them, even though these actions be spontaneous.

Introducing a new branch of industry in the national economy demands extensive consideration of various decisive factors from which it may be judged /1/ whether the new industrial branch may, with reasonable efforts, be realized at all /ii/ how it fits the present structure of the considered national economy and, within this, that of the industry /iii/ what principles should creating this new industrial activity. The smaller a country is the more crucial is the demand for an industrial branch, the functioning of which is guaranteed in a way that leads to the desired economic objectives. Concerning bigger countries, the functional conditions as well as the resources of the country are less restricted, and, therefore, the consequences of creating a new industrial branch may very well serve just, for instance, an increase in job possibilities, that is in itself a usual must if the considered country is either densely or highly populated.

Every country, desiring to establish a new branch of industry, should, for the sake of rational economic activity, strictly define the economic objectives for which the introduction of a new branch of industry is to be realized.

From this it follows, that fundamental changes of the national economy, its development, perspectives should constantly be analysed and on this basis such branches of industry might be initiated, whose right of existence in the national economy is secured and which serve the effective development and strengthening of the considered economy.

In Table 1 we compare the performance conditions of various industrial branches.

Relative figures are given with respect to those of the telecommunication and vacuum industry. The table reveals that next to precision engineering, telecommunication forms the most labour-intensive section, and apart from manpower it requires minimum efforts.

Table 1

Comparing performance conditions of various industrial branches by indices given per worker

in %

Serial No.	Denomination	Total production	Material cost	Capital investments	Power consumption	Natural gas consumption	Water consumption
1	2	3	4	5	6	7	8
1	Telecommunication and vacuum industry	100,00	100,00	100,00	100,00	100,00	100,00
2	Metallurgy	294,50	408,10	395,70	1164,00	2286,00	6103,40
3	Machines and mechanical equipments	133,90	147,60	139,20	111,80	45,70	115,50
4	Transportation	156,20	196,60	280,40	145,00	73,00	167,20
5	Electrical machines	176,70	222,20	133,00	142,20	0,04	-
6	Precision engineering	89,10	83,90	94,30	62,10	17,70	89,60
7	Metal ware	132,80	164,40	105,00	122,80	3,70	56,90
8	Chemical industry	247,70	369,10	428,80	815,20	2165,90	3093,10
9	Paper industry	184,50	238,80	320,00	759,00	-	4479,30
10	Food industry	360,10	555,70	241,20	188,60	21,50	1208,60
11	Textile industry	109,80	126,80	126,50	174,50	-	220,70

Lead by aforesaid motives, let us survey the main characteristics affecting the establishment of a telecommunication industry; those which are the typical ones and should be considered when starting this industrial branch. Because of the number and variety of telecommunication products, represented by a wide scope from typical mass production to the individual production of small series, this study may serve merely as a scheme.

Prerequisites in technology and economy

The growth of demand for products of telecommunication is correlated with the social economic development, industrial progress, life standards and national income. This growth of demand does not by itself motivate the need for establishing telecommunication industry in any national economy.

Introducing telecommunication industry has its certain prerequisites to be warranted in order to realize production plants. Firstly, because the developing countries satisfy their needs for products by way of import until the time when their economic facilities enable them to shift to a more profitable way of production, replacing the import e.g. buying production licences. In these latter case telecommunication plants in a developing country are typically put into operation for assembly work, based on imported components which may in the future be replaced by home-made products.

The prerequisites of developing telecommunication industry are as follows:

a/ a sufficient size of the country with a proper home-market for the manufactured products;

b/ appropriate purchasing capacity of the population;

c/ availability of the necessary investments that are in a long run necessary for developing local telecommunication networks;

d/ government policy, supporting the development of telecommunication industry;

e/ appropriate availability of raw material and energy;

f/ an existing machine industry and the availability of other industrial branches necessary for cooperation.

The above criteria are first to be studied when considering the possibility of establishing telecommunication. The next question is /i/ which of the two main branches in telecommunication industry has the most chance for establishment or /ii/ can both branches be simultaneously be developed. These two main branches in telecommunication industry are:

- the manufacturing of radio and television sets and other general commercial telecommunication products, and that of professional telecommunication equipments.

In countries where technology is underdeveloped the principle of step-by-step industrial establishment should be followed and, therefore, it is reasonable to start with the manufacturing of the aforementioned commercial telecommunication products for the following advantages:

- manufacturing of these products is less elaborate, their technology, organizing labour is easily acquired, an economical home production can more readily replace import;

- step-by-step specialization from assembling components to complete production can be more readily accomplished, capital investments return within a shorter period. Because of these advantages foreign manufacturers prefer to establish plants for the production of general commercial telecommunication products.

Because of the complexity of professional tele-communication equipments, it is only worthwhile to create such an industry provided technological and other circumstances enable this to become a basis for developing an extensive national telecommunication network. This should be emphasised because professional telecommunication industry is, mainly as far as engineering development is concerned, an industrial branch specifically appropriate for well established countries. While the import saving feature of any industrialisation in a big country may remain predominant through several decades, such a role of industrialisation can be maintained in a small country, only throughout a short period. After an initial period any industrial branch created specifically for saving import in these countries has to arrive at an exportable level and has also to gain foreign markets. It is, therefore, relevant to develop a fruitful cooperation of professional telecommunication industries among these countries at a level that is sufficient for the stable maintenance of economic production.

Basic features of professional telecommunication industry are technological complexity, a big variety and number of the employed components and devices, and labour-consuming production. /This latter may be seen in Table 1./ These data illustrate that there is much less possibility to introduce step-by-step industrial procedures, i.e. it is a more complex manufacturing necessary from the beginning. In addition, a higher percentage of the workers has to be highly skilled, and there is of course, a well-organized production necessary. Provided production arrives at this level only after too long time, production costs will be definitely higher than those of foreign manufacturers. This is the main reason while foreign companies decline from financing such production in developing countries. They prefer to have these projects be financed by the very country. The first question that generally arises is, from what sources, by what methods of accumulation should investments be covered in spite of capital short-comings.

The compulsion to economise capital is evident. To scrutinize the rate of return of the capital is very important. The return of investments, as far as domestical investments are concerned, is, to a great extent, influenced by investment return period /time of amortization/. The greater the pressure because of capital shortcomings the greater attention should be paid to shortening the return period. When establishing a plant with equipments imported from abroad, the costs of the return period have also to be calculated in foreign currency. This is not a complicated procedure since the foreign currency spent on equipping the new plant must be reckoned from the saving of import /calculated in foreign currency too/ and that saving presents itself after the plant begins its work.

Rapid development in technology in our time sets the task of creating the plants with up-to-date equipments. As a matter of fact every plant cannot be equipped with up-to-date technology because of capital shortcomings; however, efforts should be made to solve this problem and in the course of development find the way to employing modern technology without any significant losses. From this point of view there is a versatile opportunity for the professional telecommunication industry for replacing manufacturing devices by an increased number of manpower; carrying out this procedure, however, care should be taken not to impair the quality of the products. This technique may be employed by countries having an excess of manpower. But even in this case there should be an appropriate technological level achieved in order to accelerate the progress in national economy. Possibilities of the national economy, the choice and the optimum manufacturing capacity should be carefully studied. Concerning general commercial telecommunication products the first criterion of choice is the purchasing power of the population. On the other hand, as far as telecommunication equipments are concerned, the purpose should be to produce equipments that satisfy the most important demands of national economy and which, at the same time, ensure stable production throughout a long period.

In this respect telephon-exchanges stand ahead of other telecommunication equipments with the advantage that relatively fewer skilled workers are required, sub-assemblies are mass-produced, development requirements are relatively less urgent and a standard equipment type can be manufactured throughout a longer period.

General criteria for production-planning are as follows:

a/ the quantity of production per year, based on selling-possibilities at home and abroad in the long-run;
b/ the possibility of obtaining components and devices within the national economy or ensuring import for a long period;
c/ rational organization of production;
d/ the impact of technology, productivity, capacity and investment of technological equipments and the interrelations of these;
e/ energy /power/;
f/ transporting facilities;
g/ manpower and its qualification;
h/ minimum demand of fixed and current assets;
i/ the possibility of developing the scheduled plant at a minimum cost.

Besides production facilities within the plant, plant size and geographical environment are also to be taken into account.

Organizing production

After defining the product and the optimum capacity of production, the technological-economic questions of the production organization have to be carefully studied. When doing this one should consider what degree of assembly work should one introduce at the very beginning, taking economy and available skilled manpower into account. Essential feature of this study should be a careful defining of the manufacturing completeness to be attained in the course of the development. Before raising the plant, appropriate legal and financial arrangements should be made in order to assure continuous operation in a long run.

The structure of the production is defined by the following factors:

- The way of locating the manufacturing units; time required by these units for completing their products. /Requirements for labour force and manufacturing equipments./

Table 2 presents the flow-chart of producing units. /It illustrates techniques characterizing a small series production of complex telecommunication equipment./

The complexity of the product and its technological characteristic features the prerequisites for manpower requirements /the need for training and the required time/, and also for the assembling facilities required for the production. Particular attention must be paid to storing-facilities, proper organization of continuous raw material supply and various additional facilities.

When manufacturing telecommunication equipments, it is not reasonable, because of economy, to start work only in an assembling plant. It is more advantageous to have also a number of preceding procedures, requiring, however, only moderate skill from the labour force to be employed. Table 3 shows a typical flow-chart used in telecommunication equipment manufacturing.

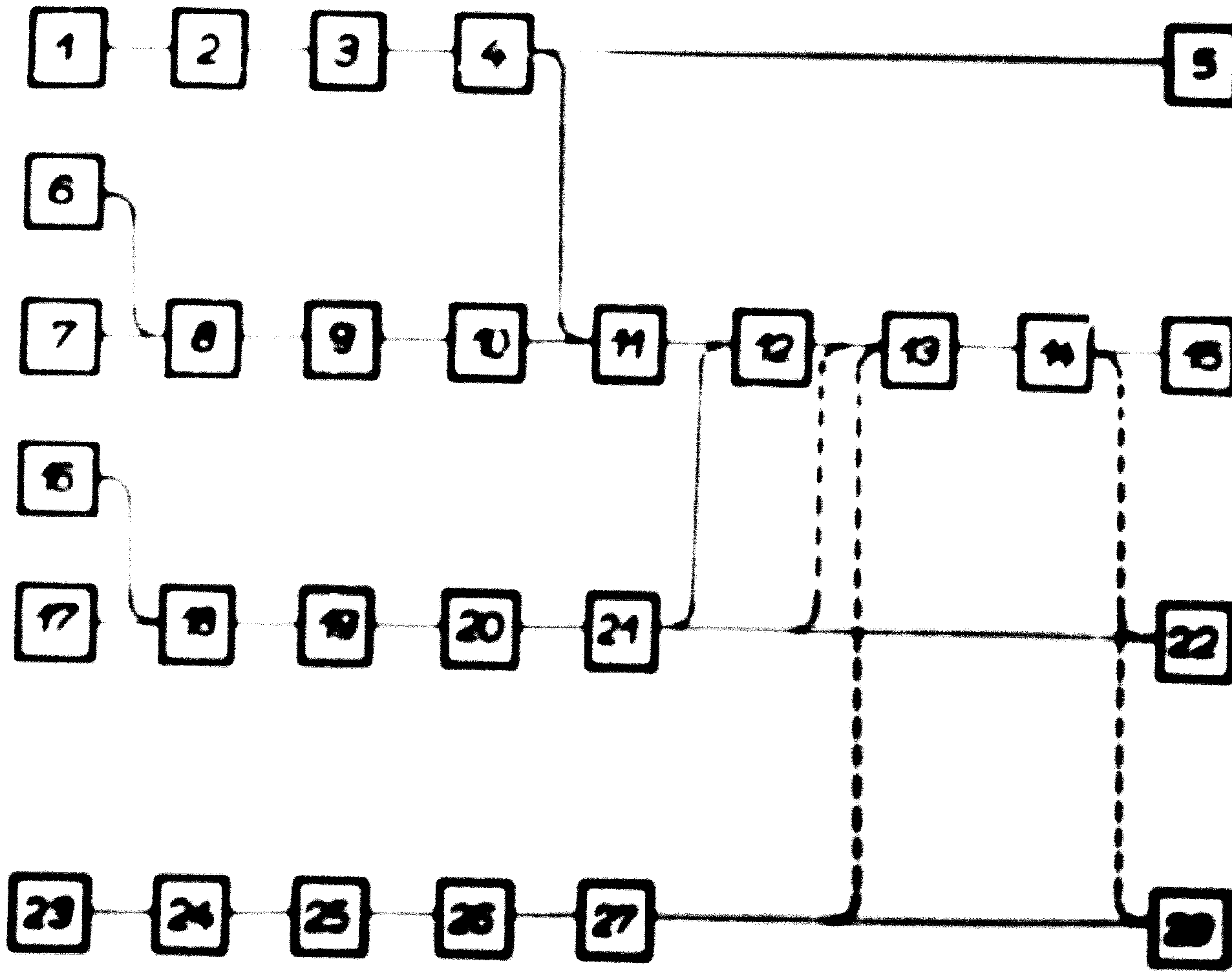


Table [illegible]

Installation flow-chart of [illegible] telecommunication equipments

1. Unit assembly
2. Electrical adjustment
3. Final adjustment
4. Final test
5. Packing
6. Preparing of cable-bundles
7. Mechanical assembly of racks
8. Rack-wiring
9. Ring-out
10. Test
11. Placing units into rack
12. Electrical adjustment
13. Final test of stations
14. Super test
15. Packing
16. Preparing of cable-bundles
17. Mechanical assembly of units
18. Wiring of units
19. Ring-out
20. Electrical adjustment
21. Test
22. Packing
23. Preparing of cable-bundles
24. Mechanical assembly of unit accessories
25. Wiring and ring-out
26. Electrical adjustment
27. Final test
28. Packing

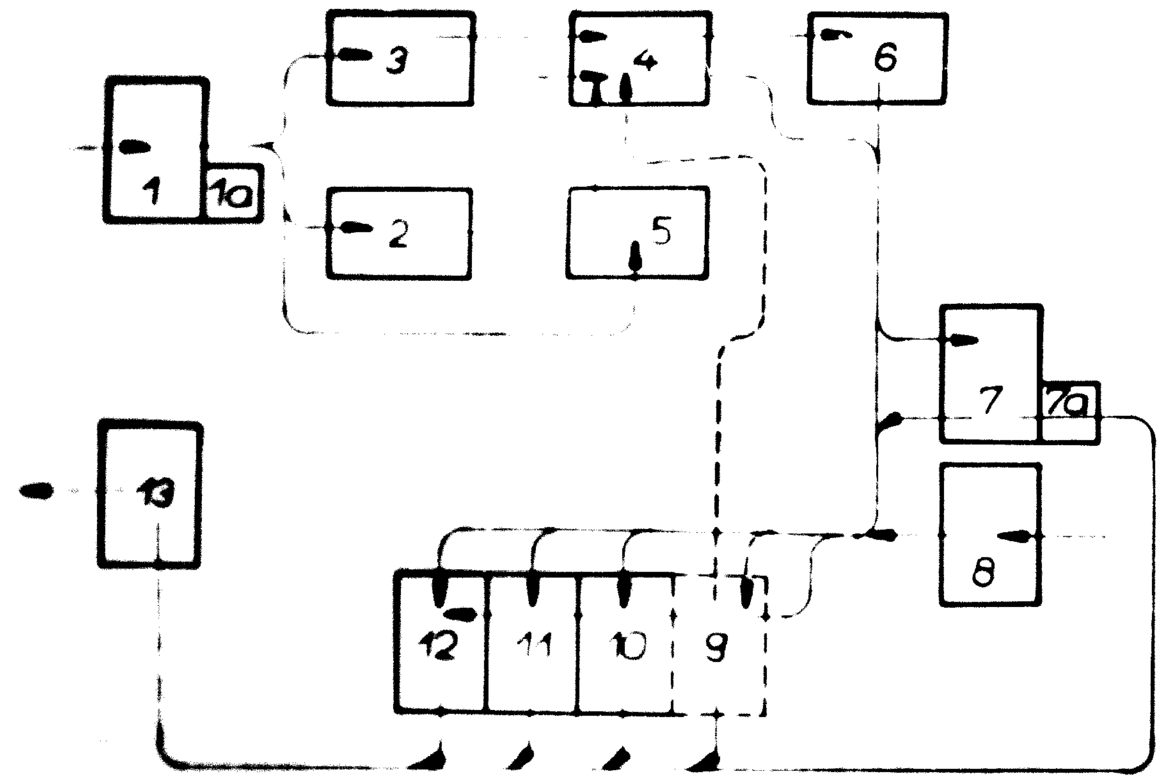


Table 3

Production flow chart of plants manufacturing telecommunication equipments

1. Iron and metal /raw material/ store

1a. Sawing shop

2. Cold-press shop

3. Cutting-machine shop /automatic turret-lathe, milling, boring/

4. Electroplating and painting shop

5. Locksmith-shop

6. Plastics shop /thermosetting and thermoplasting/

7. Semi-products store for components workshop

7a. Packing shop /for components and accessories to be delivered/

8. Store for electrical, and other semiproducts and components purchased

9. Shop for special component manufacturing

10. Assembly workshop /for diverse products/

11. Pre-assembly workshop /manufacturing of mechanical and electrical assemblies/

12. Final assembly-shop /with electrical adjustment and final test-up/

13. Store for final products /with packing facilities and suitable loading ground for delivery/

Typical relative time needed by the various manufacturing units is in per cents as follows:

- automatic machine-tools	1,o
- turret machines	o,9
- drilling machines	1,9
- milling machines	1,o
- cold pressing machines	1,4
- locksmith work	5,8
- electro-plating and polishing	1,6
- painting	4,7
- plastic material production	5,2
- assembling	76,5
Total:	loo,o

Provided there is an adequate annual volume of production, mass-produced elements are manufactured in the work-shops for mass-production, while elements requiring either piece production or special knowledge, are manufactured in a separate shop /Table 3, section 9/.

Time requirements for a typical product

At companies manufacturing telecommunication equipments, the capacity requirements and the number of workers are, usually, derived from the time needed for the manufacturing of a typical /average/ product.

This technological, economic index is given by the firm issuing the licence and know-how. This standard time has to be carefully studied and adapted to the local facilities, plant features and technology to be employed. Knowing the standard time one may figure the necessary amount of the equipments and the number of workers needed for the scheduled production.

The working hours per week to be determined according to the law and conventions of the country. It is usual to have 42-48 hours per week.

The number of shifts are defined by considering the availability of manpower and the cost of equipments. The average situation in telecommunication industry is to have about 1 1/2 shift. As a general rule expensive machines and equipments should be operated in three shifts. This is the reasonable course. Full day losses per year should be subtracted because of holidays. Time losses because of machine repairs should also be taken into account.

The following table gives a typical example for this schedule. Annual schedule: 24 hrs x 365 day = = 8760 hrs; 100 %.

Standard working time		Losses according to the schedule	
8 hours x 2 shifts x x 306 days = 4896 hrs	56 %	/free shifts, cessation of work, free days, holidays/ 3864 hrs	44 %
Nominal working time	50 %	Additional losses /absence of equipment, accessories, repairs/	6 %

Basic working time	45 %	Losses within a shift /according to measurements/	5 %
Effective working time	43 %	Useless work /deviation from technology, faulty product/	2 %
Technological time	4o %	Maintenance of machines /setting, oiling, test run/	3 %
Machine-time	2o %	Secondary time /starting and stopping machines, quality control and other handworks while the machine is out of work/	2o %

Materials and components required

Telecommunication products and equipment are, insofar as use of material is concerned, characterized by relatively small quantities but by a great variance and demand for special quality. To specify this variance of materials for telecommunication products in detail is extremely difficult within the frame of the present study since the constituents of the products are multi-fold and complicated. For the sake of illustration, we name some of the factors influencing the variance, choice and quantity of the material:

- type and design of the particular product,
- technological level of the product /e.g.: using vacuum tubes, transistors, integrated circuits, coils, etc./,
- designs requiring special materials,

- restrictions involved by measures for increasing the productivity /using strip-material instead of plates, rolled screws instead of cut screws, etc./.

In spite of the difficulties described, the author has compiled some data, concerning the use of materials in the telecommunication industry, for the purpose of a first orientation.

Quantity of some materials required for the production by 100 workers /tons/year/

iron castings	0,25
rolled steel	5,82
rolled steel tubes	1,20
steel plate	21,5
hot rolled steel bars	0,75
steel bar drawn	1,65
steel bar, cold rolled	0,92
cold rolled steel strip	2,15
cold drawn steel tube	0,26
rolled copper products	0,45
cold rolled brass	2,25
drawn and rolled bronze products	0,45
cold rolled zinc products	0,35
aluminium blocks and castings	0,64
other aluminium products	1,85
copper and bronze castings	0,05
tin-lead solder	0,30
resistance wires	0,01
copper wires	1,32
basic materials for plastics	3,00
plastic foils, plates	0,35
paints	1,30
sulfuric acid	0,32
muriatic acid	0,38
paraffine, vaseline	0,02
cotton	0,03

paper and cardboard	6,02
packing paper	5,60
woodenware	25,40 /%/

The previously enumerated materials amount to 5-15 % of the material cost. Specific quality demands present themselves in connection with materials serving telecommunication purposes. Such are: magnetic materials for transformers etc., spring materials, wires and cables. Of the latter two a great variety is required. Within the very same size a variation of 8-10 can be found, variously insulated /enamelled, silk- or cotton-insulated wires, etc./.

A significant part of the cost of telecommunication products is formed by semi-conductors, RC elements, crystals for filters and oscillators of various sorts, of precious metals /gold, silver, palladium/ and other components. The number of the needed types of components is such that even the developed countries lack the economical way to produce every needed type of them. Countries with few raw materials can produce telecommunication products with satisfactory economical effect by procuring active and passive components from other countries. It may occur that the required components cannot be procured on the market chosen. In that case it is sometimes expedient to modify the design in order that an economical supply should be facilitated, bearing in mind, however, that the quality of the product should not be affected beyond the limits chosen.

Problems of labour forces and their training

Telecommunication is a highly labour consuming branch of industry. In the course of production the technological and organizational complexity grows. The most qualified labour force is needed for the final test of the end-product. There is also a considerable number of learned labour-forces needed in tool-making and repair-maintenance.

Below we present some data concerning the labour force in telecommunication-equipments manufacturing.

Denomination	Product		
	Equipment for telephone-exchanges	Transmission equipment	High-power radio-transmitters
1	2	3	4
1. Total number of workers	100,00	100,00	100,00
2. from these: skilled workers	29,40	34,80	70,80
3. Share of the most important trades /from 1/			
turner	1,72	2,88	5,08
miller	0,95	2,10	1,32
locksmith, fitter	4,73	5,52	8,61
metal-polisher	0,21	0,43	1,32
galvanizer	0,53	0,24	0,88
welder	0,25	0,36	0,22
electro-mechanician	8,80	19,80	18,10
mechanic	4,80	16,20	21,00
tool-maker	2,40	2,55	2,00
electrician	0,70	0,40	0,80
joiner	0,60	0,45	0,40

1	2	3	4
4. The rate of women workers /from 1/	63,40	55,50	30,70

The rate of skilled workers and women workers indicates the degree of mass-character in the various branches of manufacturing.

The above data show that when organizing production the most important features concerning labour-force are:

- the need for a small number of trained labour-force at the start of the production,
- care should be taken that when expanding production capacity the facilities for the continuous training of skilled workers should be provided.

Similarly, we must acquire technicians, and persons with engineering education. Other personnel /administrational, auxiliary/ must be trained in order to guarantee the desired state of organization and management in this highly labour absorbing branch of industry.

Other essential aspects of production

As we have already pointed out, when introducing the production of telecommunication equipments, it is practical to start simultaneously with the production of certain components. The provision of general and special tools needed for unbroken production should carefully be attended to. For this purpose permanent supply should be ensured by contracts until the tool-making base of the new plant is in a position to do this work itself. The provision of capital should be continuously ensured until the planned capacity is completely developed.

Introduction of small and single-purpose machinery in order to improve productivity should be carefully studied together with the party issuing the manufacturing license, and decision should be made on the basis of technological and economical considerations, viz. which means are actually needed or not needed in the plant. This consideration is motivated by reasons of economical capital investment.

Choosing the site of the plant

When choosing the site for the manufacturing plant, many aspects have to be considered.

The site for the plant should not be choosen purely from the stand-point of the plant itself, but national economical aspects of local industrial development should also be taken into consideration. Therefore it is desirable, when establishing a new plant in developing countries, to analyse all present and future social, economic and political impacts. Telecommunication manufacturing plants do not differ in this respect from other kinds of industri ' plants. Their consumption of power is generally somewhat less than in the case of some other kinds of industries. However the surroundings of the plant should not be unduly noisy, dirty and airless. In consideration of the aforesaid, it is of advantage to establish the telecommunication plant in the vicinity of an industrial centre. This would present a good chance for employing women. Settling in the vicinity of a greater settlement would reduce the need for incidental investments.

Before adapting a final decision it is advisable to prepare at least two possible investment projects completely with all technological-economic calculations. However, the most economical solution is not always the most favorable in respect of general national aims.

In the case of choosing for the interests of national economy a less advantageous site, it is advisable to ask aid from the government in some form, in order to compensate the disadvantages by appropriate legal and economic facilities.

The comparison between the different solutions is to be carried out in two stages. In the first stage the most essential requirements should be scrutinized; the sites should be compared and those that seem suitable should be selected. Then the selected sites should be compared in more detail on the basis of investment and production costs.

In comparing several alternatives the usual course is to consider the following circumstances:

a/ the costs of preparing the piece of ground for building:
- the size, relief, slope of the land,
- quality of soil, subsoil, etc.,
- cost of clearing the piece of ground from older buildings, if any.

b/ factors concerning the operation of the establishment:
- economic, social and cultural conditions necessary for the labour force,
- cost of transportation of raw materials and products needed.

c/ factors influencing the necessary incidental investments:
- distance from housing centres, cost of establishing new housing centres,
- sanitary conditions of the environment and the necessary social investments,
- the public utilities available /water, gas, power, etc./ and the costs of their extension, if needed.

When selecting the site of the plant the possibility of future extensions should also be kept in mind.

II. SELECTION OF TELECOMMUNICATION EQUIPMENT

Selection of the equipments to be manufactured

Telecommunication equipments are produced in an extremely wide range of assortments, beginning from those of the simplest means of old times up to the most modern equipments using space communication. It is, therefore, no light matter to decide what equipments should be manufactured at the start, in a given country. It is expedient to select the type of equipment most suitable for manufacturing in the given country, by applying the principle of exclusion. This principle implies, that taking the wide range of equipments, we decide what equipments should not be taken into consideration for manufacturing under the given local conditions.

Types of equipments, which cannot be decidedly excluded should undergo a more detailed examination and the selection may be narrowed by interaction; so a final decision will be reached, concerning the family of products most suitable to start with when building up a telecommunication industry.

We cannot review here the full scale of telecommunication equipments but can present some example as an illustration of the above explained method.

Radio transmitters

Such equipments are produced one at a time or in quite small series. Expensive parts of a great variety are needed, the production of which in small quantities is quite uneconomical and which therefore must be bought elsewhere. Assembling radio transmitters is done chiefly by highly skilled mechanicians and measuring equipment of high precision is needed.

Production of radio transmitters under such conditions is therefore only possible in close cooperation with a concern issuing a license and giving permanent aid for making use of the newest technological improvements.

It is a generally recognized fact that the production of transmitting equipment is feasible only when and where the production of receiving sets has already reached a certain quantitative and qualitative level.

Transmission equipment

Transmission equipments require a great variety of components. These components are manufactured in moderate, but mostly in small series. The production and control require a high degree of instrumentation.

The scope of transmission equipment is wide. There are equipments transmitting the information via /i/ open wire lines and cables /ii/, radio-relay lines /iii/, and /iv/ communication satellites. The application facilities of the equipments are, therefore, very different. The choice of the equipment type is influenced by the number of transmission circuits to be used along a given route. Increasing of the volume of mass-production, unskilled, or semi-skilled workers can be employed, provided that there is a well-trained technical staff available.

For the adaptation of new equipments to the local manufacturing conditions a considerable engineering staff is indispensable.

Telephone-equipments

For telephone equipments, the production of a great number of identical components is generally required, together with a big requirement for tools. A large amount of iron and non-ferrous materials is needed but at the same time the sorts of items to be imported are less.

For telephone-exchanges only a few types of components are to be produced. For the production of exchanges much material and limited labour-costs are needed. Predominantly semi-skilled labour, a fewer number of skilled workers with a thorough knowledge of the technology, and finally, a relatively small number of highly qualified workers and technical staff are employed.

Telephone exchanges can be classified according to different points of view. Since it is not our intention to enter into a full discussion of this problem, we shall just enlist some types of exchanges from the viewpoint of switching elements and control equipments. The following systems are widely used.

Step-by-step systems

The heart of these systems is a switch, the movable part of which is stepped by operating and releasing of a clutch. These systems require a relatively great amount of maintenance, the switches are mechanically stressed and a very good quality of material is needed. But at the same time the system design is simple, the circuitry is easy to understand and, as a result of these factors, only routine work is required from the maintaining personnel.

Rotary systems

In Rotary Systems the moving part of the switches is rotated, rather then stepped. Therefore the energy requirement for the repeated stepping of the switch is eliminated, but permanent rotation is used.

Crossbar exchange

Crossbar systems are considered to be more up-to-date systems. The motion of the crossbar switch is similar to that of the relays used for operating these switches. The maintenance required here is far less than with the previously mentioned systems. The production of the crossbar switches is relatively simple, but requires high precision. Their life-time is generally higher but the control circuits are more difficult to survey. From the maintaining personnel mainly electrical rather than mechanical skill is required.

Crossbar exchanges with electronic control

In another type of crossbar exchanges, the above mentioned crossbar switches are used, but they are electrically controlled. In the production of these equipments electronic components /semi-conductors, ferrites, RCL elements/ have a great significance and production is to be extended by technological processes previously not used. Maintenance requirement is lower. Life-time is longer but better training is required from the production, as well as the operating personnel.

Electronic exchanges

Electronic exchanges are still at the stage of development. They are considered to represent the most advanced system. Their production involves high precision, a high grade of instrumentation, many skilled workers and a large engineering staff. Maintenance, on the contrary, requires minimal staff but of a high degree of technological knowledge.

Influence of existing economic and technological environment

The existing economic and technological environment of a given country determines in many ways the equipments to be produced. From this point of view, in addition to the above stated principles, it is desirable to study the characteristics and range of the exchanges being manufactured and operated in the given country. When the national telephone network is not uniform, it is a matter of interest what quantity of the various types of exchanges is being operated in the country. In preparing a decision, the sources of material available should be taken into consideration as well as the possibilities of the training of specialists. It is important and should, therefore, be carefully analysed how would the geographical conditions effect the development of a uniform communication network. Different networks are needed, if a large area of the country is desert, or if there are rivers and lakes in the country or if it is covered by mountains. Another factor is the density of population, the localization of industrial centres, the trend and general level of international relations.

Relation between equipment production and the operational aspects of the manufactured equipments

For adoption to home production, an equipment suitable to the national requirements of the country should be chosen. Production should be organized in conformity with local possibilities.

Specialists for starting the production can possibly be taken over from available equipments being operated, but in the course of development personnel needed for operating the plant will have to be trained and put to the user's disposal by the factory. Since the factory is at the early stages of the production making efforts to satisfy, in the first place, home needs, care must be taken that experiences gained in the course of operation should systematically be returned to the producing factory for raising and improving the quality of the production.

In some cases production and operation by the same company may be practical, especially in developing countries. This case should be compared with the expected results of independent production and the most suitable form should be chosen. Before choosing the system to be adopted for home production, it should be investigated what restrictions, conditions and costs are connected with the right of production and what technological, economic, financial, etc. assistance is the party, issuing the license, willing to undertake.

III DETERMINATION OF PROSPECTIVE DEMAND AND PRODUCTION CAPACITY

If a telephone exchange is adopted for production, the next step is to determine the production capacity needed. It is unambiguous that the quantity to be produced influences the selection of the system. It is obvious that in case of a relatively small production volume it is advisable to produce a smaller design the production of which requires a relatively much handwork, especially if the smaller design involves also simpler operation of the exchange. In case of a large production volume however the mass-character of production is one of the determining factors on systems-selection. Considering these, the proper action is to judge the economic effects in this sense.

It is a basic point that the planned capacity should be determined primarily for home demands and possibility of export should be considered only when technology is already fully mastered.

Determination of home demands begins with the estimation of the prospective demand for telephone sets. It is rather difficult to make estimates in advance, and for this reason, some general rules have been derived from experience. Two main factors are involved:

- the growth of the population
- the pace of economic development

These factors are correlated to the "telephone density index" which shows the number of telephones per 100 inhabitants. Besides these generally accepted estimation methods it is expedient to check the past 10 year development in another country with similar features and adapt the result.

In order to define the requirements in a country, it is necessary, to ascertain the number of telephone-sets to be set up per-year, to know about the needs concerning transit traffic. The volume of equipments to be set up is determined jointly by these two data. Jointly a careful study of the financial, credit and other circumstances, concerning production capacity, is needed.

Production capacity, stepwise development of manufacturing activity

It is not absolutely necessary to develop the full production capacity at once. For economical reasons it seems more advantageous to establish production step-by-step.

Generally two methods are possible in the course of adopting a production process. According to the first of them, at the beginning ready-bought components are assembled, and production is then gradually extended in a reverse order to produce sub-assemblies and later the components itself. According to the second method, production begins with the manufacture of components and is extended step-by-step to make the final product. Mostly local conditions determine the best compromise between these two methods.

Comparing these methods of adopting a manufacturing process, it becomes evident that the first of them has its advantages from the standpoint of the needed amount of capital investment, because a final product can be turned out using a minimum of manufacturing equipment. The second method, on the contrary, demands that all the means of production should be put to work gradually according to plan before a saleable final product can be made. In this manner a considerable amount of capital is immobilised for a time.

Nevertheless often the second method is chosen, if an existing relatively large plant adopts some new product for manufacturing, viz. in that case it can be presumed that at the beginning only a small capital investment is needed, particularly if production begins on a rather small scale. Its financial position will enable the enterprise to bear the additional burden, caused by taking up this new branch of production, in the hope to increase its profits in the future.

If, on the other hand, the production is to be realized in an area where conditions and skill of industrial work are still underdeveloped, it is more practical to begin with assembling bought units and components. Afterwards production can gradually be extended to manufacturing also sub-units and components. In this case however, it must be kept in mind that a considerable need for component import presents itself. But if this is assured, production will be enabled at an early time, and its extension to the production of all parts will be possible later.

In developing countries, therefore, usually only the local assembly of imported components is performed and the produced equipments are put into operation in the first period. For this procedure it is often necessary to have the help of experts from the company, which gives the manufacturing license and delivers the documentations. Such cooperation is in all cases very useful, also for the training of the staff. Import of measuring instruments, special and machine tools are needed at first for the assembling operations, the cabling and the final control, and, in addition, also for the production of the components at a later stage. Special instrumentation and single-purpose machines, not commercially available, must often be provided and a decision is also necessary about the making of such objects at the plant itself.

Beyond the aspects already dealt with when considering labour force it is worth to mention that, if there is already in the country a developed industry for mass production, but it is difficult to provide the necessary foreign exchange for the import of components, it may be useful to start component manufacturing in spite of the disadvantages formed by the larger capital investments needed in that case. In this case, time is also gained to train the labour force for the more complicated operations of assembly and final measurements, for which a highly skilled staff is needed.

In planning the escalation of production it is necessary to consider what number of workers will be required at each phase, and what number of them will be available. If a large, well skilled labour force is at our disposal, it may be desirable to accelerate the process of developing the production.

In developing a new branch of production it may be useful to cooperate with already existing inland companies for procuring some kinds of the components. This would relieve the enterprise adopting the new branch of production, from some part of its technological, productional and financial burdens. For instance, if there is already a plant producing ceramics and ready to produce resistors, this should be taken also into consideration.

On the capacity and technological level of manufacturing

It is of relevance to consider at what techological level should, in the course of the industrial progress, the various manufacturing periods be realized.

We illustrate this by an example in telephone-exchange manufacturing. Welding of cabelforms for telephone-exchange sub-assemblies is a very labour-consuming procedure. This operation is at the company, issuing the documentation, usually carried out by automatic machines, because of the high wages and shortage in manpower. It is however not indispensable that the receiving company should also employ an automatic process if enough labour force is at hand, since manual work may be as favorable and will not result in an increase of the costs of the final product. This technological process is not only example and it is therefore worth to carefully consider not just the temporary steps of the technological development but also the technological level to be introduced at each step.

How the planned capacity affects the manner of production

The appropriate technique of production depends on the extent of production capacity. When manufacturing telephone exchanges of 50.000, 100.000, 200.000 or even more telephone lines, different techniques are appropriate. According to experience, manufacturing up to about 50.000 lines per year from unit assembly to final tests can be performed in a single workshop. But when manufacturing 100.000 or 200.000 lines per year it is reasonable to mount some sub-assemblies, such as relays and machines, in one workshop, and the rest of the sub-assemblies as well as the assembling and tests of the final product in additional workshops.

When manufacturing more than 200.000 lines, a further sub-division of manufacturing and assembling is needed according to the available manpower and to local conditions. The particular sub-division should be specified after a detailed study of the whole situation.

IV PRODUCTION PREREQUISITES

Labour-force

Investigating the various phases of production, we find that need for labour force is presenting a rather varying picture when various systems of telephone-exchanges are compared. For the previously defined four exchange systems we may estimate the manpower needed in the various stages of production from the following table, which contains rounded average values, because the necessary labour force depends also, more or less, on many other circumstances.

Required average production time per 1000 lines

Items	Rotary exchanges	Crossbar with electronic control	Crossbar exchanges with electro-mechanical control I	Crossbar exchanges with electro-mechanical control II
	hours	hours	hours	hours
1	2	3	4	5
Component production				
pressing	1200	1000	1600	800
milling	400	200	200	100
automatic tools	1000	600	1600	1000
turret lathe	700	200	400	200
boring	700	300	700	400
finishing	600	100	400	200
locksmith	1400	2300	2600	1400
casting	100	-	100	-
plastics	800	1500	2500	1500
mechanicians work	500	10000	1000	700
Assembling				
switches	-	4000	9700	2300
relays	4700	4200	5400	3300
other devices	3800	600	12000	7800

1	2	3	4	5
cabling	11oo	28oo	71oo	45oo
final assembly	11ooo	1oo	11ooo	7ooo
Control				
electrical tests	2o	16ooo	5oo	3oo
Total of required hours	2782o	459oo	508oo	315oo

We have to consider to what extent can the tasks be solved by employing trained and highly skilled workers, respectively. Only a small percentage of skilled workers are needed for press-machine, boring machine and plastic-press work. It is justified to employ an overwhelming majority-approximately 9o % of trained workers. For milling, automatic turret-lathe and casting shops, skilled workers should be employed. In the locksmith-shop the employing of 5o % trained labour force is already a fairly good result. In component manufacturing it is a question what percentage of women workers can be reasonably employed. Women can be employed anywhere, where trained or skilled workers are needed. Women may be employed however only if the educational system gives also women the chance to become skilled workers in all these kinds of works.

At assembly-operations we usually have to reckon with trained labour-force and only in supervision is professional knowledge necessary. The management of the production plant should fill these positions with professionals who have actual experience in manual labour and who have already proved their ability to lead this sort of work. Women labour may be used more extensively for semi-skilled work, but usually about at least 1o % of man-workers is also desirable. At operations like finishing and electrical tests, because of either the physical requirements or the needed higher grade of professional experiences, the proportion of man and woman workers is reversed. The proportion of semi-skilled and skilled man and woman labour force also greatly depends on the volume of production. With the growth of production the proportion of man workers and skilled labour force usually decreases.

__Raw material and components__

It is quite natural that the quality and the life time of telephone exchanges depend on the quality of the materials used.

It is also obvious that for the mass production of any of the considered kinds of electro-mechanical telephone-exchanges the same sort of materials is needed; nevertheless, there are important qualitative differences in the necessary parameters of the employed materials.

The amount of raw materials necessary for the considered four types of telephone exchanges is given in the following table:

__Average material requirements for 1000 telephone lines__

Items	Quantity				
	Unit	Rotary ex-changes	Crossbar exchanges electronically controlled	Crossbar exchanges electro-mechanically controlled Type I	Type II
1	2	3	4	5	6
Soft magnetic steel	kg	362	1120	1442	1300
iron materials	kg	6014	5965	10341	6000
non-ferrous metal	kg	3208	770	1036	1065
precious metals	gr	1013	6065	16091	30000
wire for coils	kg	407	308	810	830
cable-wire	kg	302	1867	1333	270
switch cables	m	-	3000	15360	3000
plastics	kg	403	217	180	160

1	2	3	4	5	6
laminated board	kg	129	159	270	110
transistors	pcs	-	7364	360	-
diodes	pcs	-	23496	10000	1000

/A more detailed specification of materials is given in Supplement 1./

Power, water and gas resources

Requirements for these resources are usually of no problem since the demands of the telephone manufacturing industry in these respects are very moderate. We shall, therefore, be concerned only with some questions related to electric-power requirements viz. the figures necessary for manufacturing about up to 150.000 lines per year.

Power consumption in kW hours per day

I t e m	light	motors	thermionic devices	other	total	Direct current consumption /Ah/day/
Metal cutting and pressing	450	3200	-	-	3650	-
locksmith shop	330	810	-	-	1140	-
foundry	16	14	-	-	30	-
plastics shop	472	1860	830	-	3162	-
painting shop	530	1450	6670	-	8650	-
galvanizer	250	460	237	1700	2647	-
precision tool shop	640	364	40	-	1044	80
switch shop	1070	500	100	-	1670	270
relay shop	350	440	-	-	790	310
other sub-assembly shop	250	60	73	-	383	50
cabling	1070	130	200	-	1400	210
finishing and final tests	2000	100	100	-	2200	50

These are approximate figures and it should be kept in view that lighting depends to a large extent from the building locating the shop and motor power from the extent of the planned cooperation. Painting shops, galvanizing shops may use other sources of power. On the basis of the figures, presenting the consumption per day, the required capacity of power supply can be determined. Depending on local conditions peak consumption can be expected during 6 hours in case of an 8 hour working day and during this time 7o-8o % of the 24 hour consumption should be covered /with the exception of lighting/. Lighting consumption depends on the climatic conditions and the number of shifts. The power supply can be planned only after the locality of the establishment has been chosen.

Workshop area

The order of magnitude of the necessary area may be derived from the estimated production hours. Starting from the facts, dealt with earlier - considering the needed labour force in average production hours - the area can be derived from the following estimates:
/m² per worker/

Pressing shop	8
milling shop	6
automatic-tools shop	8
lathing shop	6
boring shop	6
repair shop	4
locksmith shop	10
precision tool shop	6
fitting and cabling	7
finishing	11
electrical tests	11
plastics shop	10

Areas for the painting and electroplating workshops are herein not included. E.g. for the manufacturing of telephone-exchange equipment of about 100.000 lines a surface of about 70 000 m² should be electroplated and 140 000 m² should be painted. About 70 workers are necessary for the electro-plating and 60 workers more for the painting.

The necessary area for the electro-plating shop is about 600 m² that for the painting shop 800 m² in case of a three-shift production.

In addition to the enumerated shop areas there are, of course, also further requirements such as area for roads, offices etc. For orientation in this respect we present here the total area needed for producing exchanges with approximately 100.000 telephone lines. This area includes also that necessary for engineering and development.

Typical data

Actual production area	24,0 %
Additional area required for manufacturing	9,5 %
Total production area	33,5 %
Area for stores	14,5 %
Office area	7,2 %
Bathes, dressing and restrooms	9,3 %
Social provisions within the plant	4,5 %
Additional area	31,0 %
Total /for an average of 1,5 shift/	100,0 %

Based on the previous considerations and taking account of local circumstances one may estimate the total investment costs of the plant to be established.

V. PRINCIPLES OF PLANT LAY-OUT

Having considered all aforementioned questions including the local conditions, the next step is to plan the lay-out of the plant in a way that offers the best possibilities for the entire plant and also for all of its parts. The whole manufacturing activity is influenced by the lay-out-plan and therefore, a number of lay-out schemes should be considered in order to arrive at a solution that is best suited to all the requirements of the investment and technology aspects of manufacturing. Concerning the lay-out plan the following principles should be taken into account:

a/ the location of buildings and establishments should offer most economical transportation possibilities for semi- and final products, according to the routing defined by the subsequent technological procedures,

b/ auxiliary shops, stores, power stations should be located near the main workshops,

c/ railroads should be near for economical transportation

d/ the transport of workers should be organized along the shortest distance from their housing to the plant, avoiding as far as possible crossings,

e/ workshops, plants with similar sanitary, fire-protection, power-consumption and transport requirements should, if possible, be located near to each other. The majority of the shops should be kept free of gases and dust,

f/ the location of the plant should make further extensions possible,

g/ improvements should be possible in all branches of technology,

h/ let the plant to be built in a pleasant environment and under conditions that are most appropriate for its manufacturing activity.

Production of small sub-assemblies should be concentrated in so-called mixed assembly-shops, where specific manufacturing operations can be carried out either manually or by using machines. Some mass-produced subassemblies, e.g.- relays, should be completed in a single workshop. Components, of course, should be provided by separate component-workshops.

Supplement 2/a-b illustrates a typical lay-out of a manufacturing plant for telephone exchanges with 50.000 lines/year. With the growth of production, the basic structure will not change, apart from the subdivision of some of the manufacturing units.

VI. SUMMARY

It is necessary to emphasize once more, that creation of a telecommunication industry in a developing country may offer definite advantages to the country, but it may also raise difficulties if all prerequisites had not been appropriately taken into account. In this report we emphasized that technological and economic requirements of operating a telecommunication plant may be defined only if the specific features of the considered products are fully known and the production technology is chosen.

In this study we have, therefore, confirmed ourselves only to some specific topics within the telecommunication industry. We have, however, tried to show that under given circumstances it is practical to create such an industrial activity. This study is not concerned with general topics in technology, economy, finance and labour training that are obviously well known in developing countries, actually building up new industries. We have not dealt with particular features of telecommunication industry, viz. that of engineering and development. Experts in the considered developing country have to consult this topic carefully with the deliverer of the manufacturing licence or know-how, taking all aspects of the market, and the technological possibilities into account.

Telecommunication industry is usually called a "key industry". This reflects the fact that equipments produced by this very industry directly contribute to the development of the infrastructure of the national economy and via this have a definite impact on relevant political, military, social, demographic and economic conditions.

MATERIAL SPECIFICATION

Supplement 1

Material	Field of application	Exchanges of conventional design	Crossbar exchanges of novel type	Main differences between the two specifications /specifications in column 3 related to that in column 2/
1		2	3	4
Soft magnetic steel /Swedish magnetic iron/		Soft unalloyed magnetic steel bar, strip, band and plate quality grade: ELFE 10 ELFE 1[illegible] coercitive force: **Max.** 1,00 **max.** 1,2o	Stripes, bands, plates Band gauge: mm — Coercive force: Oe 2,5 — 1,00±o,25 < 3,o — 1,00+o,25 -o,35 >=3,o — **Max.** 1,25 Round bars unalloyed: 1,4o±o,25 Si-Al alloyed: **Max.** o,95	- tolerances closer - bands delivered in rolls are preferred - lower limit of coercive force also specified - 1,5 % of the soft magnetic-steel requirements is Si-Al alloyed material /to be imported/
Nickel silver spring plate and band		**ALP Spring plate** **ALP Spring plate tensile strength** δ_B, **kp/mm²:** Alp 58rK — 65-72 Alp 58KrK — min. 72 **Chemical composition:** Ni = 18 ± o,8 Cu = 58 ± 1,o Zn = residual	Bands, plates Gauge — tensile strength > o,3 — 62-7o o,3-o,5 — 57-65 < o,5-2 — 53-62 Chemical composition Ni = 12 ± 1,o Cu = 64 ± 2,o Zn = residual	- the nominal Ni content 6 % , lower, Cu content 4 % higher - tensile strength lower - a few years ago precision rolled bands were introduced to produce springs for relay and crossbar switches. Band thickness: o,335 ± o,005 mm /Standard tolerance: ± o,02 mm/

1	2	3	4
Precious metal contact-materials	Nickel alloyed silver band Ag-Ni semi-hard Ni = 0,07–0,13 % Ag = residual δ_B = 25–30 kp/mm² HV_I = 70–90 kp/mm² curvature = max. 3 mm/[illegible]	copper-alloyed silver wire Ag = 90–91 % Cu = residue tensile strength ε_B = 58–67 kp/mm	A less expensive alloy type with optimum properties has been developed for applications in column 3. Contacts, made of high strength round-materials by cold forming have high surface hardness.
	Nickel alloyed silver wire Ag-Ni K Ø 0,5 ± 0,01 Ni = 0,2–0,4 % Ag = residue δ_B mm = 38 kp/mm² HV_1 = 110 kp/mm² min.	Copper alloyed, silver plated copper band Ag = 90–91 % Cu = residue Hardness = precious metal: HV = 135–160 kp/mm² Copper bearing layer: HV = 125–150 kp/mm	
Precious metal contact materials	Palladium-alloyed silver-band and wire Ag-Pd semi-hard and hard $Pd_{min.}$ = 30 % Ag = 69,5–70 % other metal traces 0,5% tensile strenght semi-hard: δ_B = 25–[illegible] kp/mm² S_{10} = 25–30 % HV_1 = 70–100 kp/mm² min. = 75 % /for wires/ hard: δ_B min. = 40 kp/mm² HV_1 = [illegible]0 kp/mm²	Copper-alloyed silver wire Copper alloyed silver coated tin bronz band Ag = 90–91 % Cu = residue Hardness – Precious metal: HV = 130 kp/mm² copper layer: HV = 200–220 kp/mm²	

1	2	3	4
	curvature = max. 3 m/1m /for bands/ Palladium band and wire- band: hard wire: semi-hard Pd: 99 % Metals of the platinum group: max. o,5 % Other metals in traces: max. o,5 % Hard: δ_{Bmin} = 36 kp/mm² HV_{min} = 1oo kp/mm² Semi-hard: $\delta_{B\ min}$ = 25–35 kp/mm² HV_1 = 7o–1oo kp/mm² curvature = 3 mm/1 m /for bands/		
Laminated paper-bakelite /phenol-fibre/ plates	Laminated paper-bakelite plate Surface resistance: min. 5 x 10^9 ohm Internal resistance: min. 5 x 10^9 ohm In case of 1 mm thickness – 4 days:max. water addition 3,5 %	Laminated paper-bakelite plate Electrical requirements not specified in the standards. In case of 1 mm thickness: 4 days max. water addition 15 %	With specifications in column 3 used exclusively for mechanical purposes in small quantity

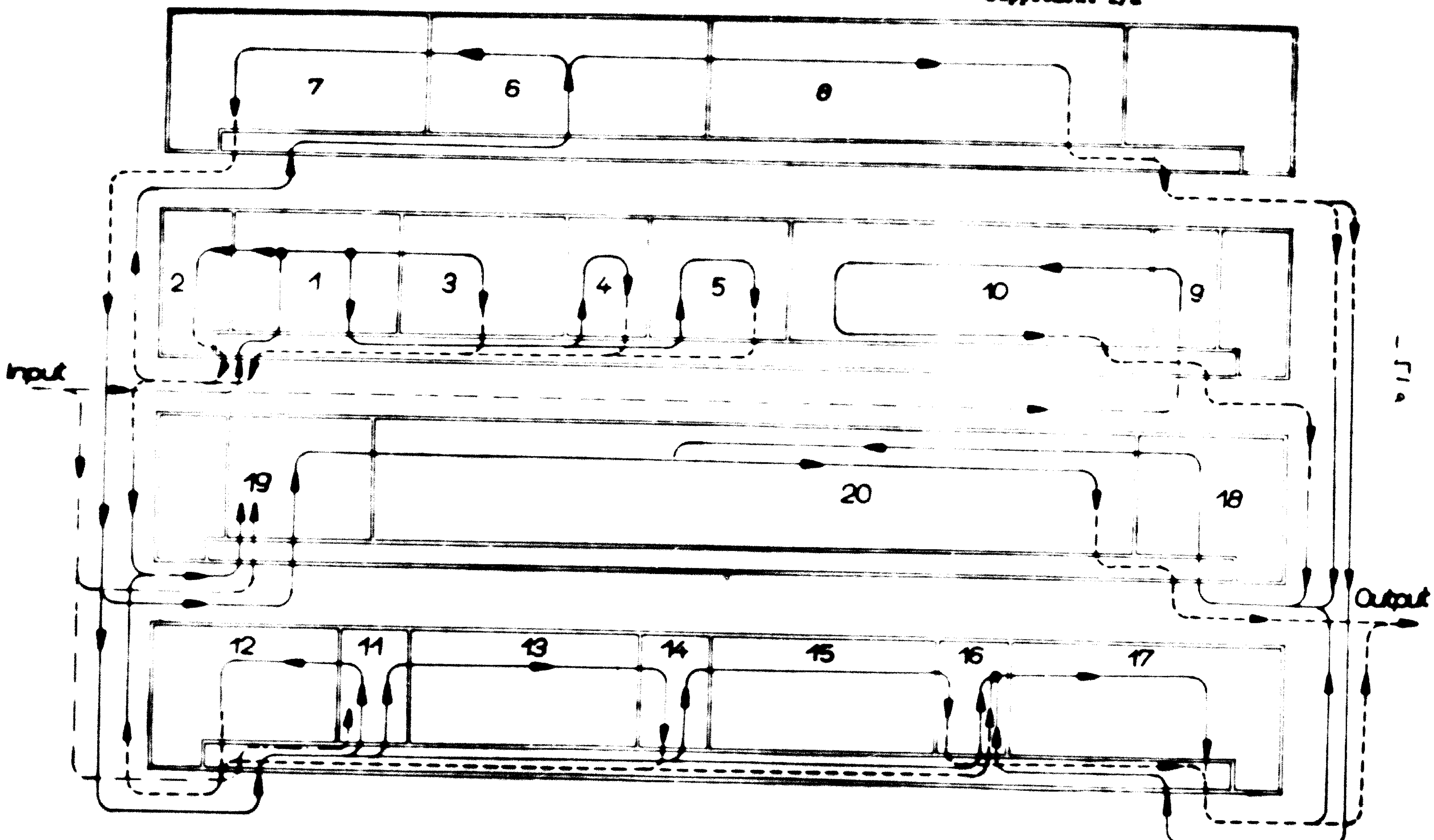
1	2	3	4
Laminated paper bakelite plates	Laminated paper bake-lite plate for special use Surface resistance: min. 5×10^9 ohm Inner resistance: 5×10^9 ohm In case of 1 mm thick-ness - 4 days: water addition max. 3,5 %	Laminated paper bakelite plate Surface resistance: min. 10^8 ohm Good cut-out by stamp-ing die is a primary demand In case of 1 mm thick-ness - 4 days: water addition is max. 7 %	With average electric-al properties, average water addition, excel-lent technological properties
		Laminated paper bake-lite plate Surface resistance: min. 10^7 Ohm In case of 1 mm thick-ness 4 days: water ad-dition max. 7 %	Material used in co-lumn 3 is a proper type, with average water intake, average electr. properties High-quality materials equivalent to those used in column 2 are not used in exchanges according to column 3
Enamelled /winding/ wire	Enamelled wire Type: polyester IV. Heat resistance class "B" - "F" 130-155°C Insulating resistance: at a relative humidity of 80 %: 20 Mohm x Km Loss factor: $tg\delta$ = max. 600×10^{-4} Enamel insulation con-tinuity: max. 100 defects/100m	Enamelled wire Heat resistance class "E": max. 120°C Insulating resistance with a relative humidi-ty of 90 %: 50 Mohm x Km Loss factor: $tg\delta$ = max. 600×10^{-4} Enamel insulation con-tinuity max. 50 defects/100 m, solderable by dipping 355 ± 5° C/3 sec.	Wire specified in column 3 - needs no blanking, can be directly soldered - at certain sizes closer resistance to-lerance

1	2	3	4
Cabling wires	Etiltext cabling wire Insulation resistance after 24 hour damp warm stress 1ooo Mohm x Km Voltage resisting capability: 1oo V, 5o c/s/1 min. Fire resistance of the insulation: meets the requirements Temperature range: -5o - + 7o°C	Plastic insulated cabling wire Insulation resistance, after 24 hrs relative humidity of 65 %: 1ooo Mohm x Km Voltage resisting capability after [illegible] hours drenching in water, /measured in water/ 1oo V; 5o c/s/1 min. Fire resistance of insulation: selfquenching Temperature range of application: -[illegible] - +7o°C	The wires are of different type. For the wire in column 3 the temperature range of application is lower, the sensitivity to thermal stress, when soldered, is less and the insulating cover is less fire-resistant
Switch cables	Switch cables with plastic wire insulation and sheath. Max. operating voltage 2oo V Temperature ranges of application: while laying: -5o - +5o°C; before and after -3o - - +7o°C Conductor core: untinned copper: Ø o,5 mm breaking strain: min. 15 % resistivity at 2o°C: o,o1754 Ohm x [illegible]	Switch cables, plastic wire plastic sheath Max. operating voltage: 6o V Max. operating voltage: 8o–9o V Temperature ranges of application: -2o - - +7o°C Conductor core: tinned copper: Ø o,5 mm conductor resistance: max. 98 Ohm/Km; 2o°C	Voltage rating in column 3 lower Temperature ranges of application differ to some extent In column 3 conductor core tinned, in column 2 not

1	2	3	4
	Core insulation: wall thickness: min. o,15 mm shrinkage: max. 10 % /15o°C/ 15 min./ tensile strength: min. 15o kp/cm² breaking strain: min. 1oo % Sheath: tensile strength and strain not specified	Core insulation: wall thickness: o,2o mm /nominal/shrinkage 2 mm /when dipped in solder/ tensile strength: min. 175 kp/cm² breaking strain: min. 125 % sheath tensile strength: 125 kp/cm² sheath breaking strain: min. 125 % /insulated wire average Ø 9o mm/	Wall thickness and wire Ø: almost identical. Test: different. In column 3 tensile strength and strain specifications stricter.
	- Core insulation coloring - Cable structure	- Core insulation coloring - Cable structure	- Color code different - Construction partly identical, partly different
	- Cable bundle wrapping - Soft plastic, gray	- Cable bundle wrapping - Soft plastic, gray	- identical
	- Cable bundle screening specified	- Cable bundle screening no specification	- In column 2 screening is specified, in column 3 not
	- Sheath wall thickness o,9-1,1 mm	- Sheath wall thickness o,6-1,3 mm	- Outer Ø 2o-25 % larger for cables in column
	- Electrical properties - insulating resistance at 2o°C: min. 3oo Mohm x Km	- Electrical properties - insulating resistance at 2o°C: min. 5oo Mohm x Km	- In column 2 specified value is lower

1	2	3	4
	- Capacitance: max. 800 Hz 120 nF/Km between a and b wires	- Capacitance: max. 800 Hz:75 nF/Km	- In column 2 specified value is higher
	- Capacitive coupling: at most 80 pF/100 m	- Capacity unbalance of cores: max. 500 pF/500 m	- In column 2 specification is stricter
	loss: not specified	loss: 1,7 dB/Km	- Not specified in column 2

Supplement 2/a



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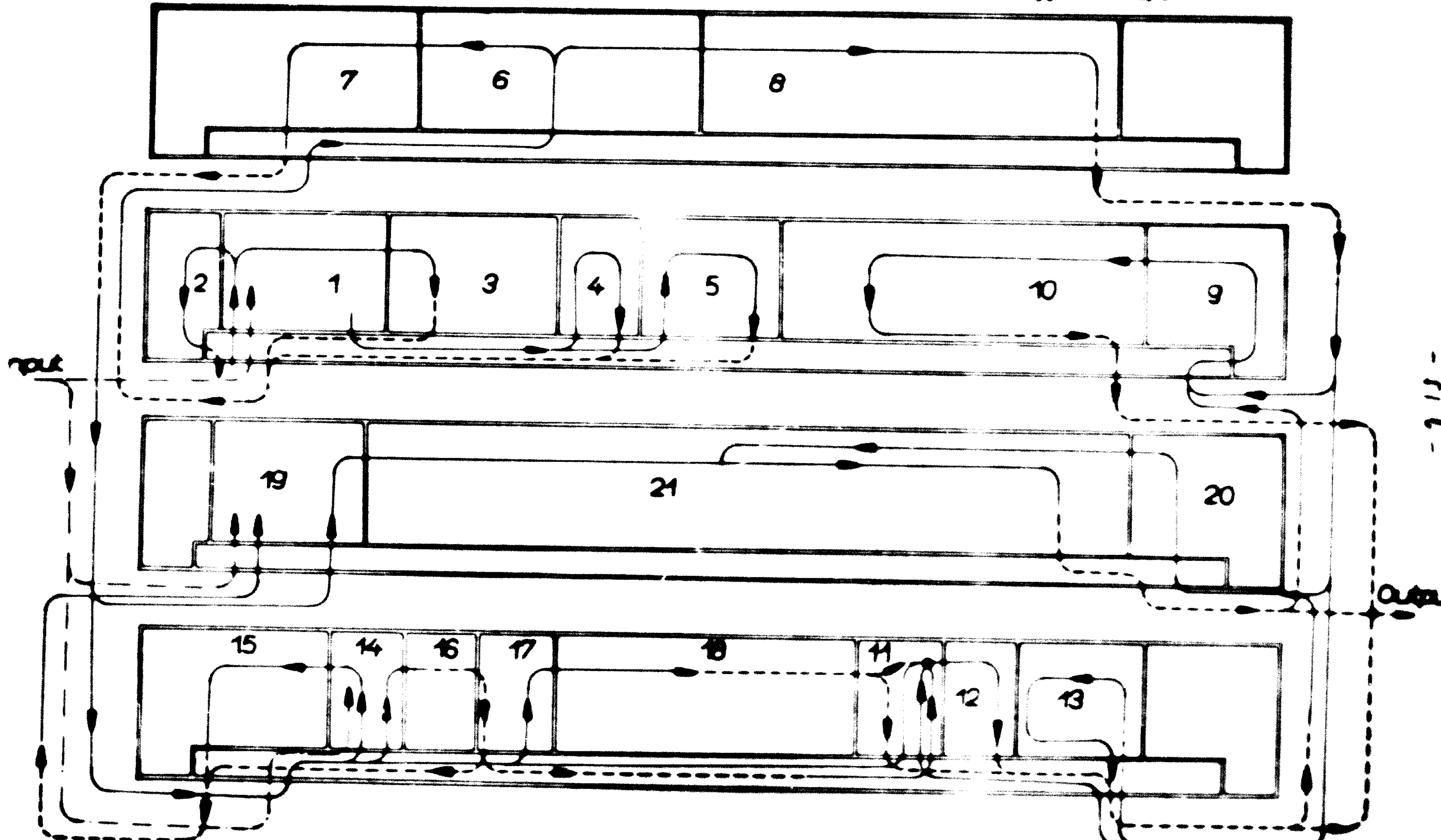
Supplement 2/b



Supplement 2/a

Scheme of crossbar exchange manufacturing

/5o ooo lines per year/

1 Store
2 Plastics shop
3 Locksmith shop
4 Pressing machine shop
5 Cutting machines
6 Store
7 Electroplating
8 Painting shop
9 Store
1o Cable-shop
11 Store
12 Switching machine assembly
13 Assembly shop
14 Store
15 Relay assembly shop
16 Store
17 Panel assembly shop
18 Store
19 Store
2o Final assembly

Supplement 2/b

Scheme of rotary exchange manufacturing

/50 000 lines per year/

1	Store	12	Panel assembly shop
2	Plastics shop	13	Cable shop
3	Locksmith shop	14	Store
4	Pressing shop	15	Switching machine shop
5	Cutting shop	16	Assembly shop
6	Store	17	Store
7	Electroplating	18	Relay assembly shop
8	Painting shop	19	Store
9	Store	2o	Store
1o	Final assembly	21	Final assembly
11	Store		

Key to signs:

Continuous black line:	Way of material flow to shops
Broken line:	Way of material from shops
Dotted broken line:	Way of purchased ware

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