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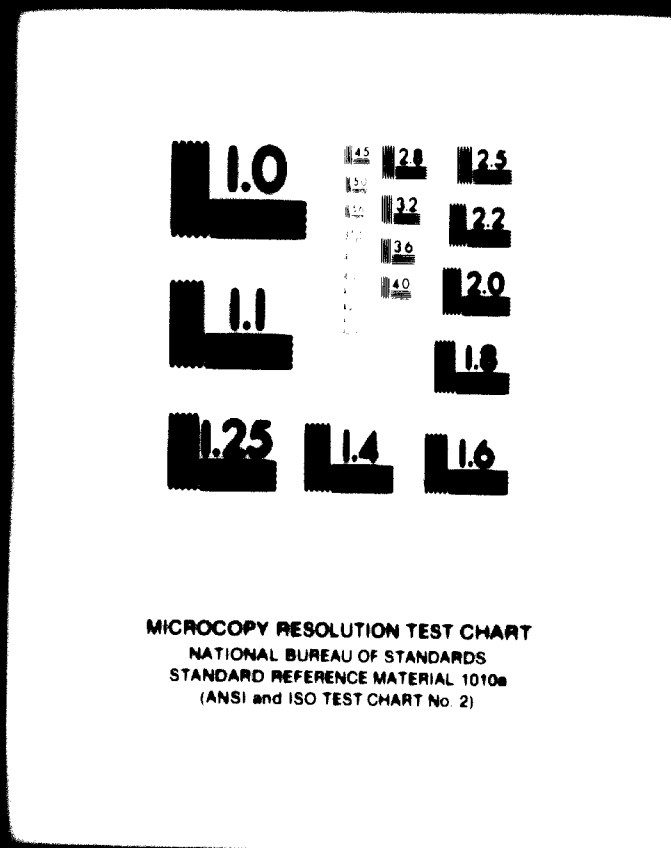
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Project Manager, UNIDO

03537

The Study

ANALYSIS AND DIAGNOSIS OF RESEARCH WORK PROGRAMME
CONCERNING THE FIELD OF BUILDING INDUSTRY, IN THE
INDUSTRIAL RESEARCH CENTRE-TRIPOLI LIBYAN ARAB REPUBLIC

Tripoli
February 1972

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Ref: LIB-12
FM : 3/72
P - IX

Tripoli
February 1972

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FOREWORD

1. Many studies and reports were given about the problems of the Libyan Building Industry and its development.

2. These studies and reports are characterised by the followings:

- a. Building Industry was considered from classic aspects as one separate specific field of a wide industrial scale;
- b. All districts of this industry were not considered;
- c. The technological processes of the Building Industry were contemplated as separate, to one another independent, fields of this industry;
- d. The approach to the problems of the Research Work in the field of Building Industry was only tangential.

3. This Study, initiated by the Director-General of the Industrial Research Centre - Tripoli.L.A.R., is different from the previous studies and reports. This difference consists of the followings:

- a. Building Industry was considered from modern aspects;
- b. All districts of Building Industry were taken into consideration,
- c. The technological processes of Building Industry were contemplated as characteristic by "unit operations" (physical changes) and "unit processes" (chemical changes);

d. The Study represents one attempt of the parabolic approach to the problems of Research Work in the field of Building Industry.

4. This Study comprises of the following parts:

- I. Introduction,
- II. Basic problems of Building Industry and its general connection with the activities of Industrial Research Centre,
- III. Basic problems of Research Work in the field of Building Industry;
- IV. The proposal, concerning Research Work in the field of Building Industry;
- V. Discussion, concerning the problems of Research Work and Work Organization;
- VI. Conclusions and recommendations;
- VII. List of symbols;
- VIII. Bibliography.

5. This Study does not comprise the consideration of the routine activities problems in the field of Industrial Research Centre, concerning the Building Industry.

6. During the period of the preparation of this Study the author discussed with some members of the Industrial Research Centre - Tripoli - L.A.R., about correspondent questions, taken in his contemplation of the Research Work problems. The author has the pleasure to express his thanks to the following members of this Centre:

- Mr. Abdulalim Sha'ari
Director-General of the Centre;

- Mr. Munir Hawisa
Director of Technical & Economic Department;
- Mr. Abdulwahed Bishti
Chief, Laboratory Section;
- Mr. Zulaytni Masaud
Chief, Personnel Section,
- Mr. Tahir El-Bishti
Chemical Specialist Assistant;
- Mr. Abdulsalim Kashim
Food-Techno Specialist Assistant;

7. The author has the pleasant duty to express his thanks to Mrs. Salma Egawhary, Librarian, UNDP Office - Tripoli L.A.R., for supplying information concerning the data of disposable and published studies and reports on the Building Industry in the Libyan Arab Republic.

8. The author has also the pleasant duty to express his thanks to Miss Sudha Tandon, Administrative Secretary Project LIB-12, for typing and arranging of this Study.

9. In the end the author is also thankful to Mr. Zulaytni Masaud, Chief of Personnel Section, Industrial Research Centre - Tripoli - L.A.R., for his very good management concerning the reproduction of this Study.

10. This Study was prepared only for the use of the Industrial Research Centre - Tripoli - L.A.R.

11. The views and opinions expressed in this Study are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. Material in this Study may be freely quoted or printed, but acknowledgement is requested, together with a copy of the publication containing the quotation or print.

I I N T R O D U C T I O N

1. Building Industry generally is very old. It would be very difficult to discover, when it was started. May be, it is older than the folk-songs. It is evident that in many folk-songs of different countries, the descriptions of processings of towers, religion-buildings, citadels, houses and cottages constructions were given. Unfortunately, it is not possible to know what were exactly technological processings in ancient times and many skills in the field of Building Activity from that time remained secret for the present-day man and may be forever. The fact is that Building Industry is of one very great importance for the present-day world and that it will last for such a long time in the future. In a parallel way with a success in different activities of a wide industrial scale, Building Industry was and permanently is interweaved with undoubtedly constant development and success. There is a great deal of statistical data about this, especially in the last years when the statisticians started to be interested of industry and economy questions more than of the data, concerning the number of chickens and hens laying eggs.

2. Research Work is also very old and there are many theses concerning it from the very beginning. In folk-songs from many countries exist very interesting descriptions of Research Works and researchers of hoary times. One very important fact is that it is not possible to imagine the progress in our world without simultaneously existing Research Work. The present-day man lends his greatest thanks to previous researchers who left him a great deal of discoverings, improvements, creations, knowledges and inventions. The humankind survived the Mechanical Revolution and now it is in the state of intensive Technological Revolution, but it is now going quickly to meet the Biological Revolution. In all these revolutions, the Research Work was, is and it will be of the greatest importance. The present time is characterised by two explosions: demographic explosion and

knowledge explosion. So many, very serious and important, discoveries were made and will be made, that it is impossible to have ideas: Where is the limit of a man's knowledge? Many futurologists from different countries are occupying by themselves and in correspondent associations with the problems of knowledge increment and very serious courageous, like fantastic, prognoses. Without entering into discussion about this question, from the aspect of this Study, it is very important to underline one expressive difference between a classic and the present-day Research Work conceptions. A classic Research Work can be interpreted as a sum of independent singular points. A modern Research Work, meanwhile, can be interpreted as a closed geometrical curve.

3. There is a great deal of the problems and questions concerning the Research Work in the field of Building Industry in the Developing Countries. Considering these problems and questions, this Study does not pretend to one complete answer but - if we are allowed to say - it undoubtedly opens the possibilities for further mezzo-and micro-differentiations of this matter.

II BASIC PROBLEMS OF BUILDING INDUSTRY AND ITS
GENERAL CONNECTION WITH ACTIVITIES OF
INDUSTRIAL RESEARCH CENTRE

1. The scope of Building Industry (BI) can generally be considered from different aspects. Without entering into a discussion about this question, one way of the consideration of the Building Industry scope was shown on fig. 1. This consideration, in our opinion, is correspondent to the modern aspects. Building Industry, as it was shown on this fig. 1, consists of the following fields:

- a. Building materials prefabrication (BMP);
- b. Building elements production (BEP);
- c. Building units production (BUP);
- d. Designing for Building Industry (BD);
- e. Building engineering (BE).

On this figure, at the same time the general connection of Building Industry (BI) with the Centre of Industrial Research Centre (IRC) was shown. Through the correspondent sections, Industrial Research Centre (IRC) solves adequate problems of Building Industry (BI). These sections are:

- a. Technological processes section (TPS);
- b. Plants section (PS);
- c. Designing section (DS);
- d. Engineering section (ES);
- e. Work Organisation section (WOS).

The connections among Building Industry (BI), Industrial Research Centre (IRC), Government (G), and University (U) were also shown.

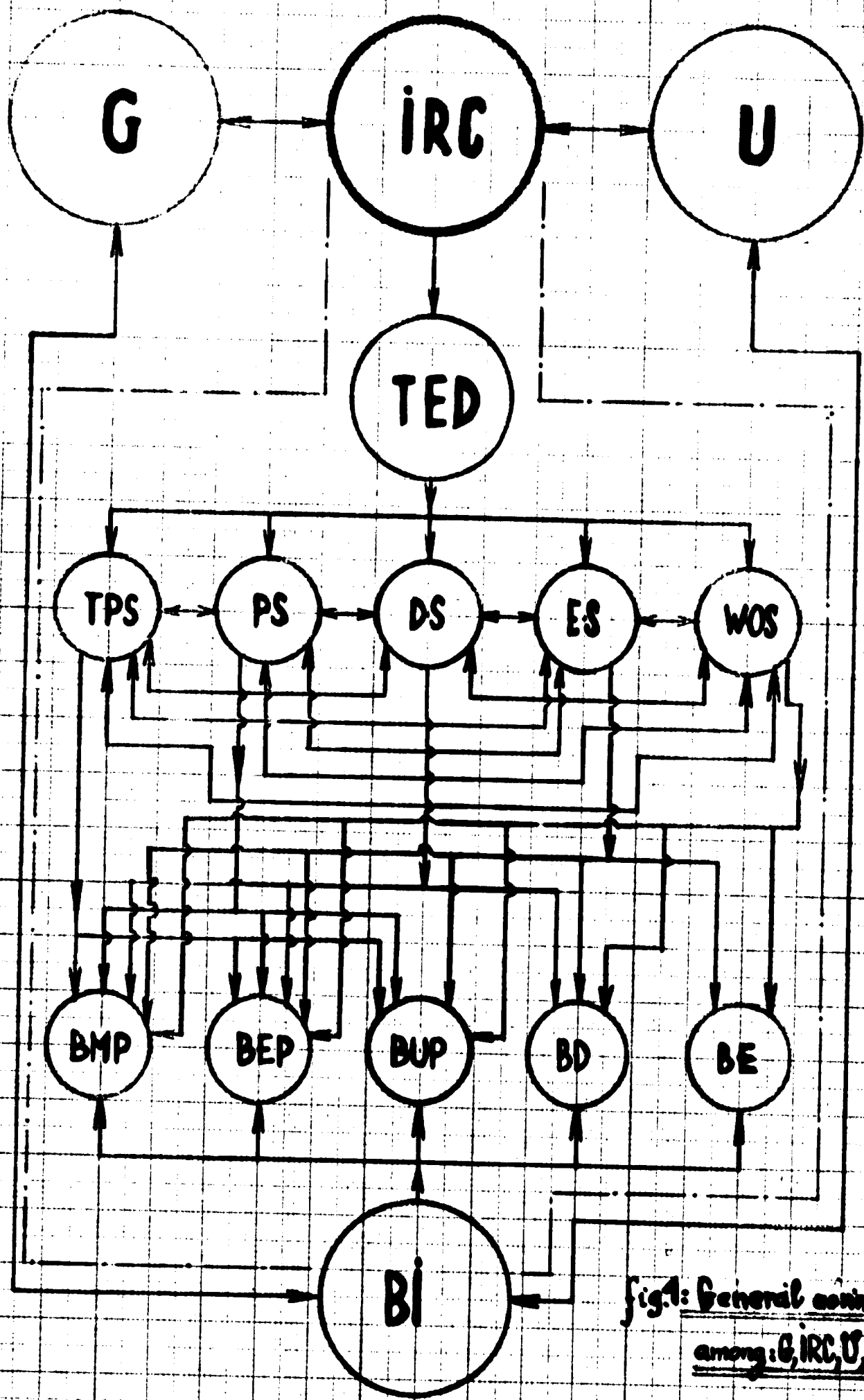


fig.1: General connection
among: G, IRC, U, BI

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2. On figures 2, 3, 4, 5, 6 and 7, the functions of above-mentioned fields of Building Industry (BI) were shown.

3. Building materials prefabrication (BMP), as it was shown on fig. 2, depends on the following parameters: raw materials (RM), technological processes (TP), plants (P), engineering (E), work organization (WO). Raw materials (RM), as it was shown on fig. 3 can be local raw materials (LRM) or imported raw materials (IRM). Both of them can be natural raw materials (NRM) or waste materials from different industries (DIRM).

4. Building elements production (BEP), as it was shown on fig. 4, depends on the following parameters: Building materials prefabrication (BMP), designing (BD), technological processes (TP), plants (P), engineering (E) and work organization (WO).

5. Building units production (BUP), as it was shown on fig. 5, depends on the following parameters: building materials prefabrication (BMP), building elements production (BEP), designing (BD), technological processes (TP), plants (P), engineering (E) and work organization (WO).

6. Designing for Building Industry (BD), as it was shown on fig. 6, depends on the following parameters: local designing organization (LDO) or foreign designing organization (FDO), engineering (E) and work organization (WO). Local designing organization (LDO) depends from Industrial Research Centre (IRC) and individual designers (ID).

7. Building engineering (BE), as it was shown on fig. 7, depends on the following parameters: local engineering Organization (LEO) or foreign engineering organization (FEO) engineering (E) and work organization (WO). Local engineering organization (LEO) depends on Industrial Research Centre (IRC) or individual engineers engaged in the field of engineering (IEE).

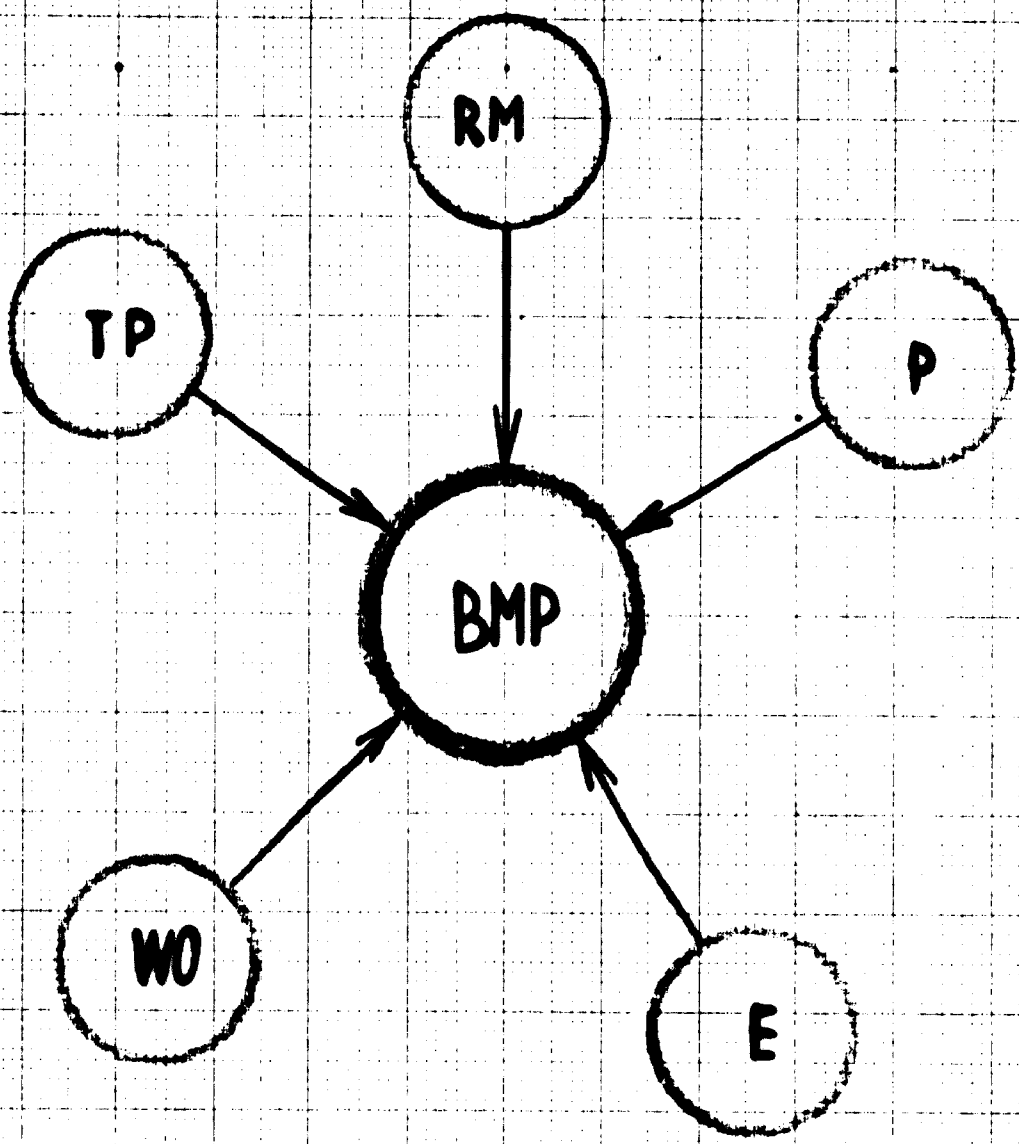


fig. 2 $BMP = \emptyset (RM; TP; P; E; WO)$ (VA)

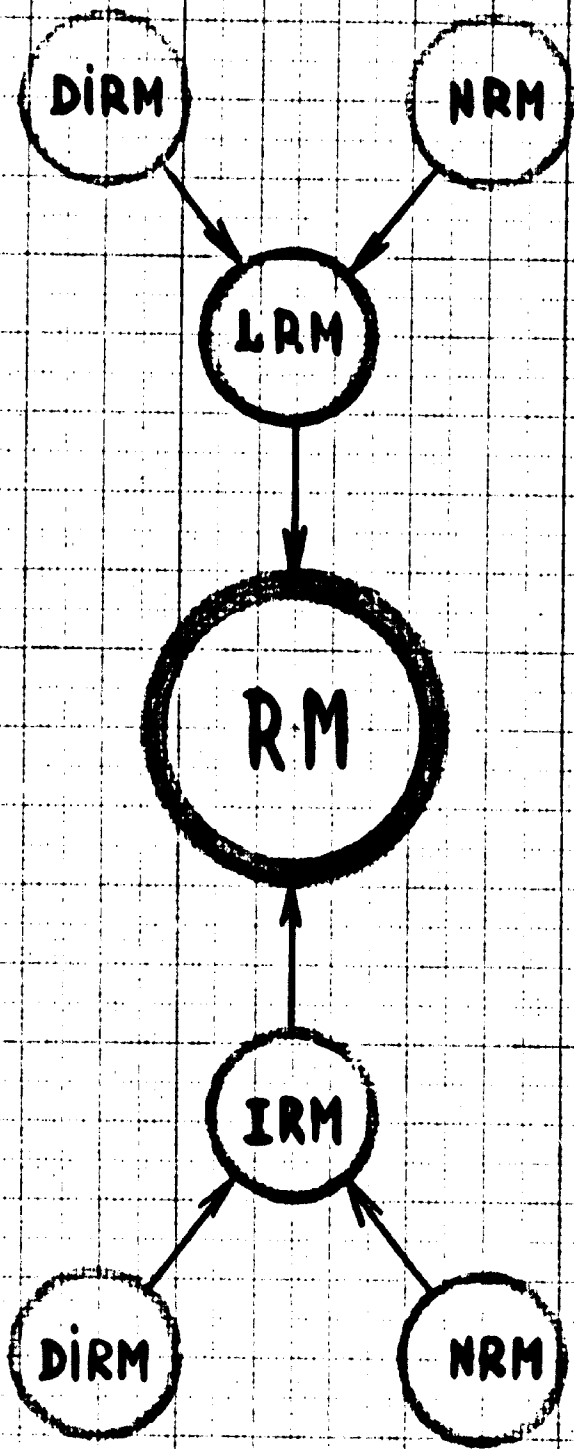


fig. 3: RM = \emptyset (LRM; IRM) (V.A)

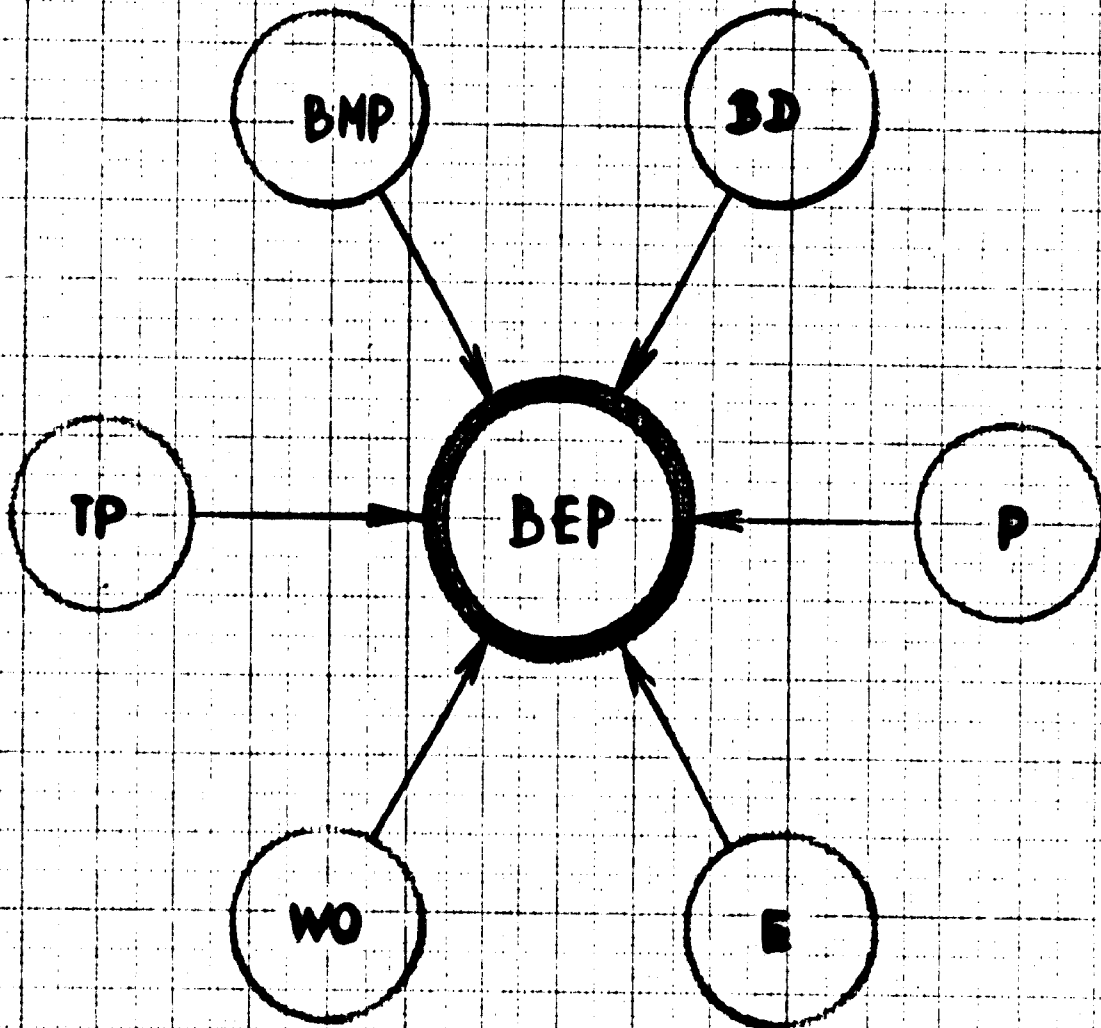


fig.4: $BEP = \emptyset(BMP, BD, TP, P, E, WO)$ (V.A)

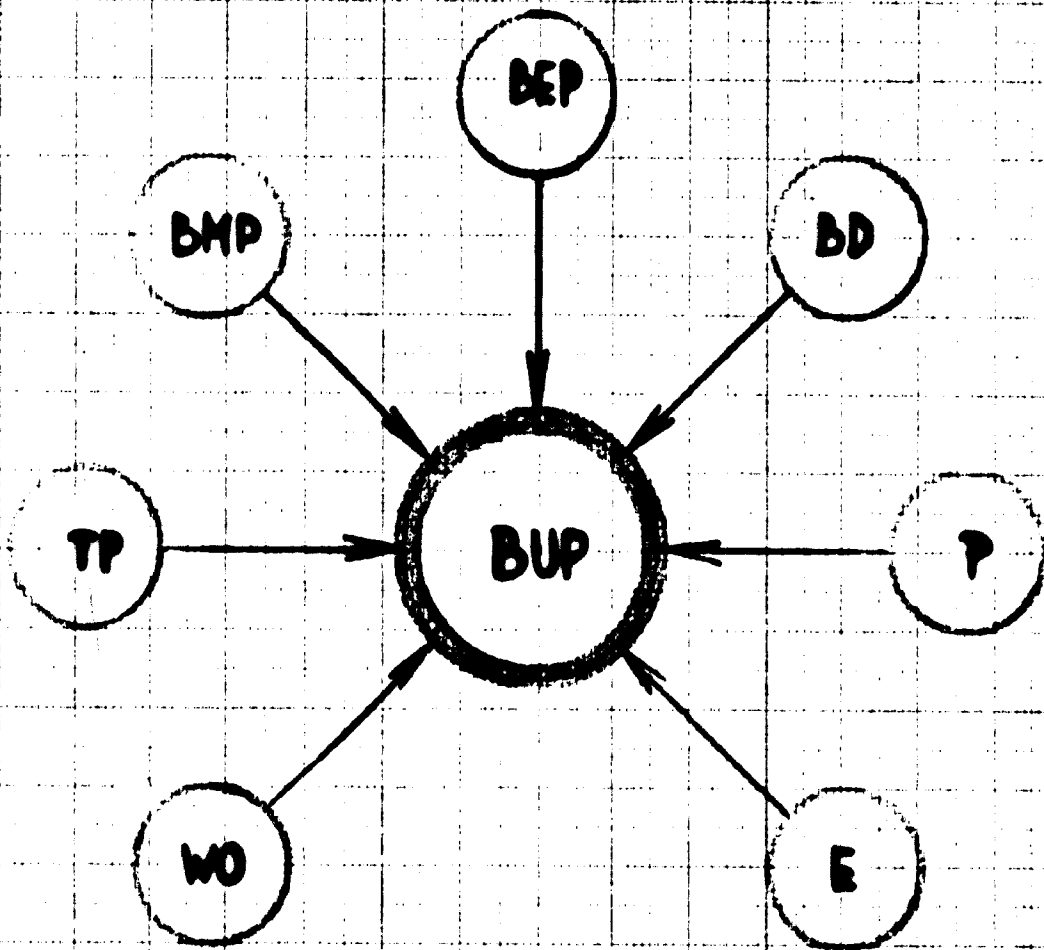


Fig. 5: $BUP = \emptyset(BEP; BD; TP; P; E; WO)$ (VA)

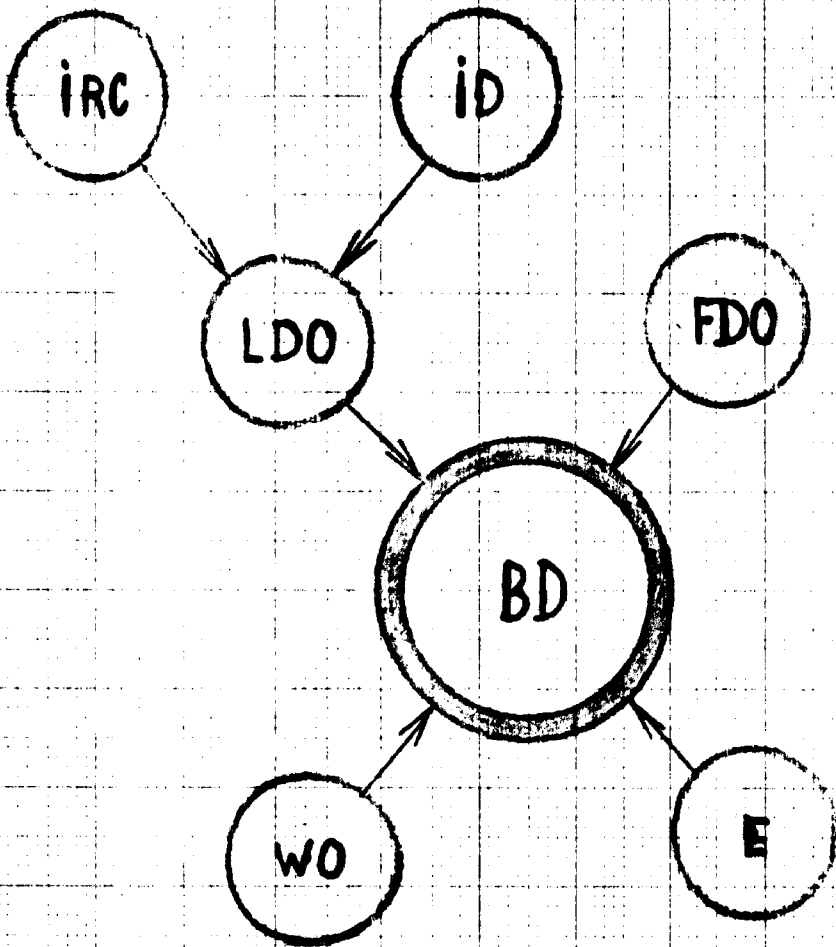


fig. 6: $BD = \emptyset(LDO; FDO; E; WO)$ (V.A)

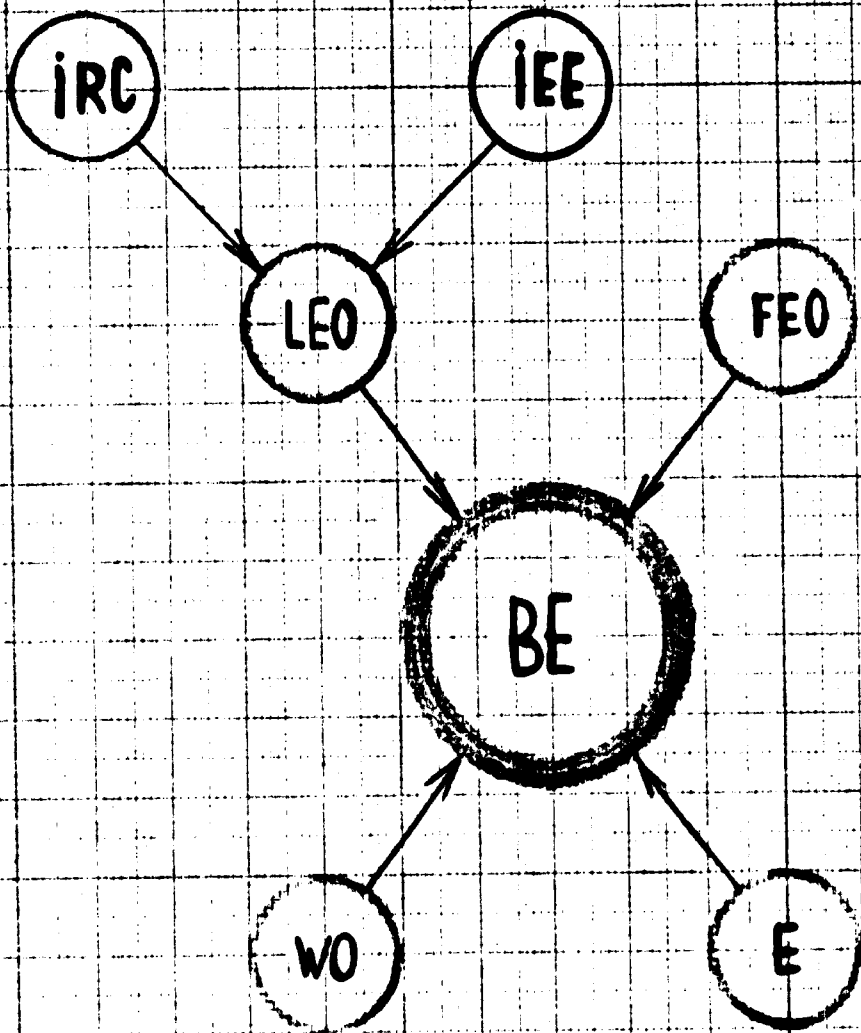


fig. 7. $BE = \emptyset(LEO; FEO; E; WO)$

(V.A)

8. From the aspects of this Study, two following problems are the most important:

- a. problem of technological processes ;
- b. problem of plants.

9. Fig. 8 represents the single scheme of the realization of technological processes design (TPD). There are three possibilities of these realizations. The first possibility is the solution given by Industrial Research Centre (IRC). The second possibility is the solution given by foreign organization (FO). The third possibility is the solution given by both IRC and FO. Fig. 9 represents the more detailed scheme of solution of technological processes design (TID), concerning the first variant (possibility). Previously mentioned sections of the Industrial Research Centre (see point 1) generally are engaged on the solution of this problem. The first step is laboratory plants design (LPD). The second step are laboratory plants (LP). The result of a work with ~~the~~ laboratory plants is "know-how" (KH). The further step is pilot plants design (PPD), necessary for pilot plants (PP) construction. The result of the work on the pilot plant (PP) will be used for technological process design (TPD).

10. Fig. 10 represents the single scheme of the realization of plants design (PD). There are also three variants of the solutions possibilities. The first variant is the solution given by Industrial Research Centre (IRC). The second variant is the solution given by the foreign organization (FO). The third variant is the solution given by IRC and FO. But for realization of the plants problems, beside (IRC) and (FO) is necessary the participating of local plants factory (LPF) and local engineering organization (LEO). The plants (P) are the result of the common work of above-mentioned organizations.

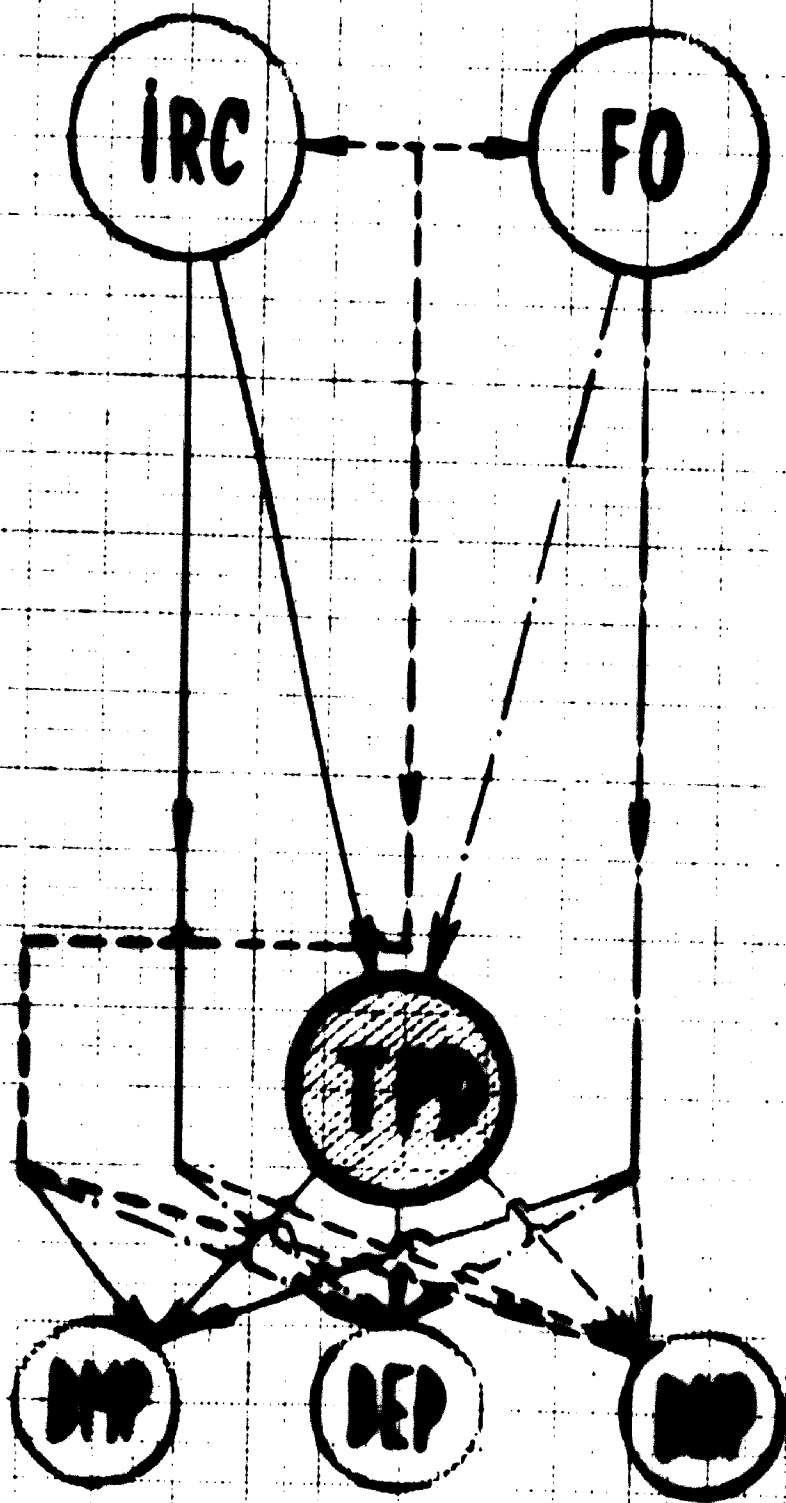


Fig. TP - 0 (IRC, FO)

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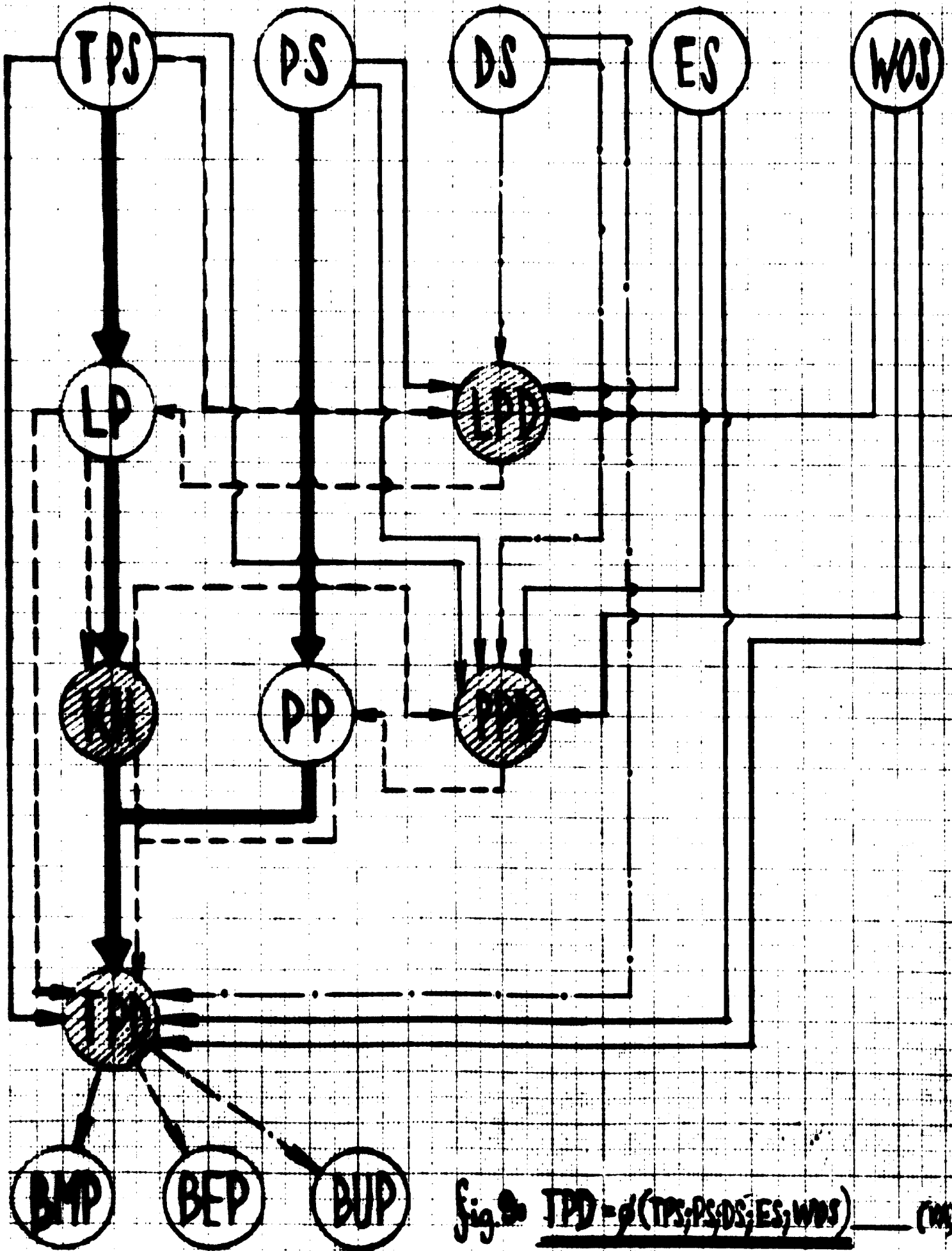


Fig. 90 $TPD = g(TPS, PS, DS, ES, WOS)$ (100)

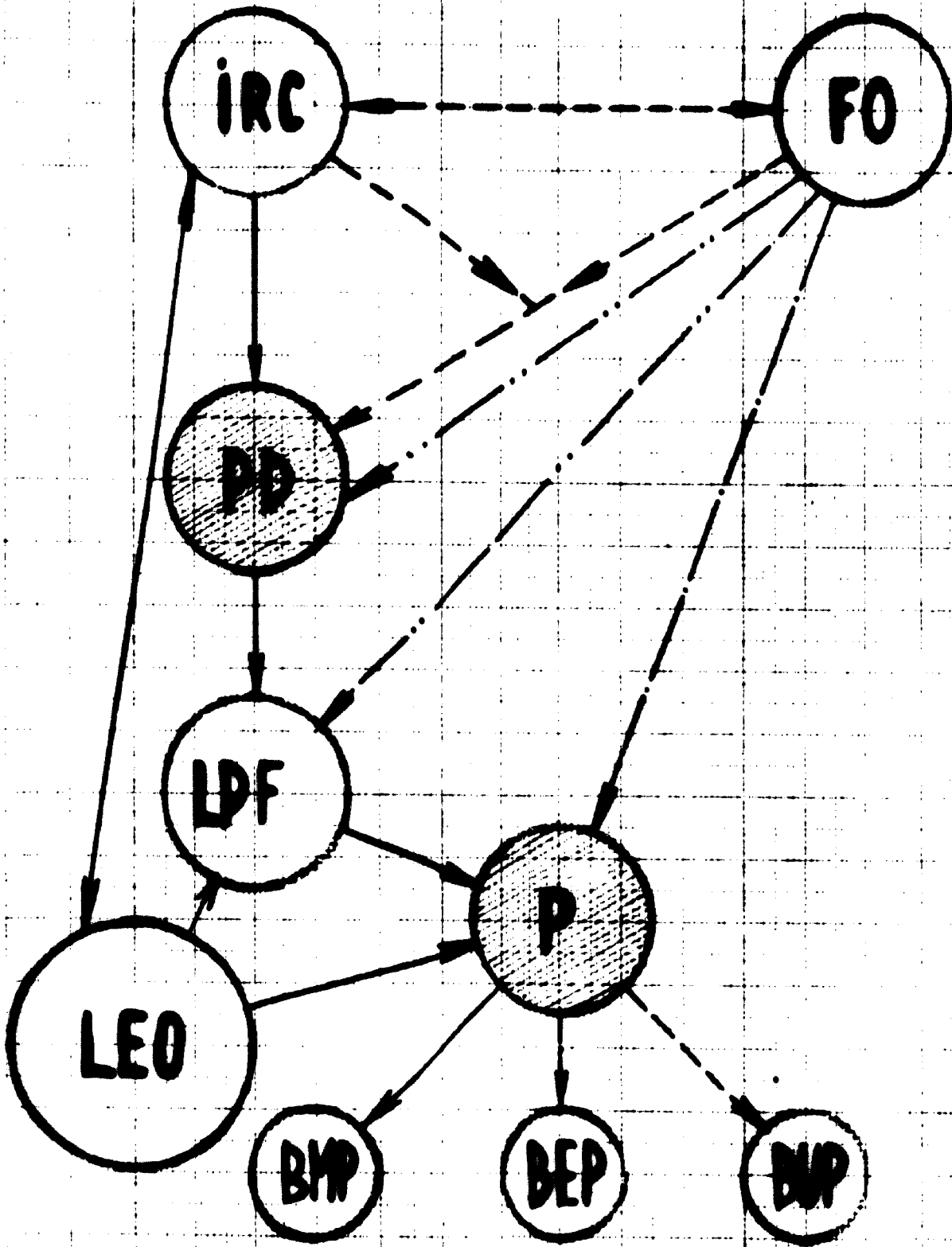


fig. 10: $P = \emptyset(\text{IRC; FO; LDF; LEO})$

(VA)

Fig. 11 represents the more detailed scheme of solution of plants problem, concerning the first variant. The previously mentioned sections of the Industrial Research Centre (see point 1) are also engaged on the solution of this problem. The first step is plants design (PD), which would be given ~~to~~ the Industrial Research Centre (IRC) to the local plants factory (LPF). This factory, on the basis of plants design (PD), prepares a documentation for construction and assembling (CAD). It also gives the plants construction (PC) and provides plants assembling (PA). Local engineering organization (LEO) has one very important role, as it was is shown on this figure.

11. The basic problems of Building Industry (BI) are:

- a. Technological processes (TP);
- b. Plants (P);
- c. Designing (D);
- d. Engineering (E);
- e. Work Organization (WO).

This estimation of the problems importance was given only from technical & organizational aspects. By reason of this, the other problems were not taken into consideration. Fig. 12 shows the variants of the problems solutions in the above-mentioned fields from the aspects, concerning the participation of local (L) and foreign (F) organizations. When the solutions are given by the local organizations, the role of the Industrial Research Centre is always very expressive. All actions are initiated by this Centre.

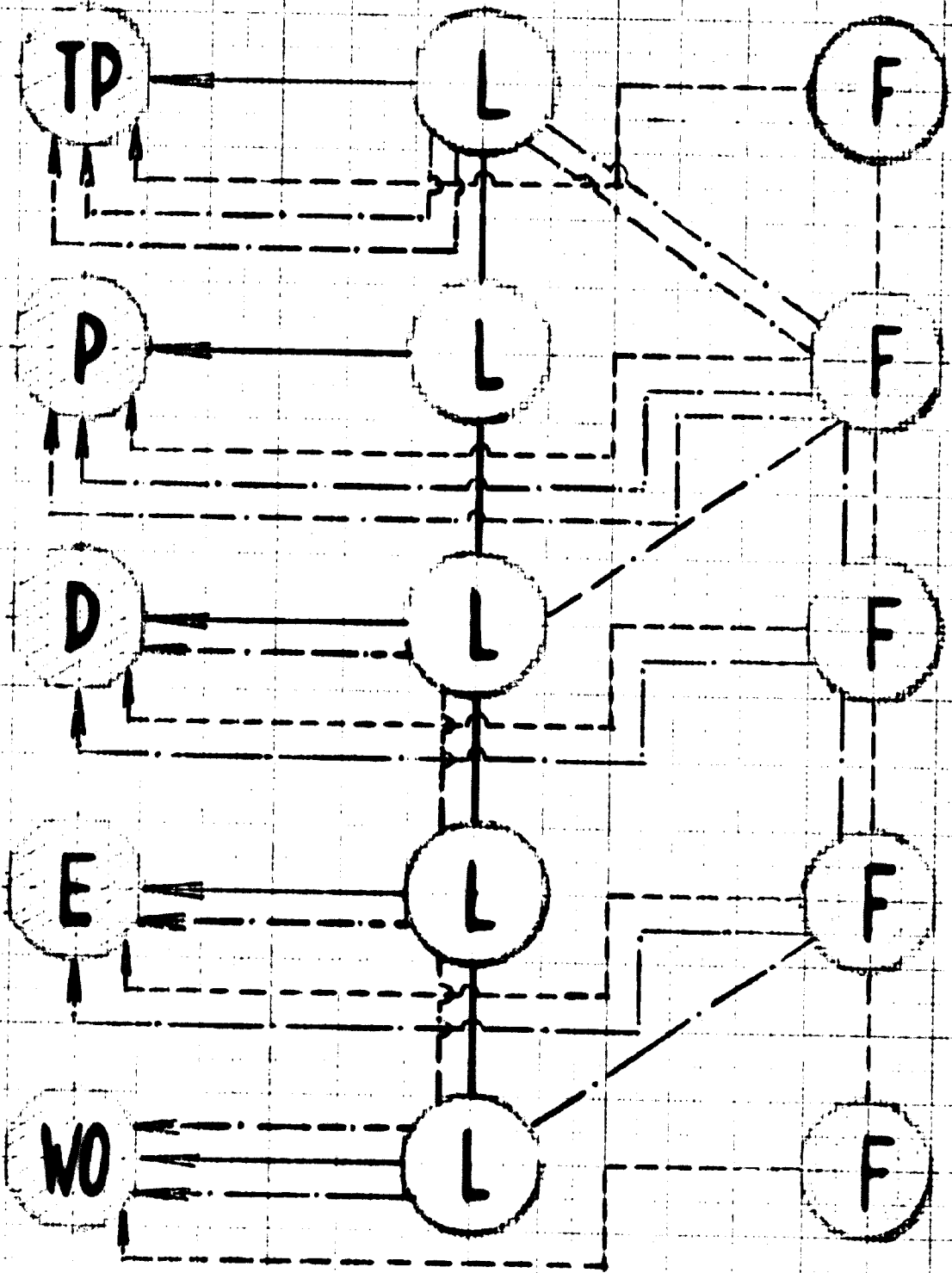


fig. 181 Relationships among TP, P, D, E, WO, L, F (VA)

III. BASIC PROBLEMS OF RESEARCH WORK IN THE FIELD OF BUILDING INDUSTRY

1. The work of the Industrial Research Centre (W_{IRC}) generally comprises of followings:

- a. Research work (ReW);
- b. Routine Work (RoW).

On fig. 13 the relationship between research work (ReW) and routine work (RoW) was shown. On this figure the relationship among fundamental researchwork (FReW), basic research work (BReW) and applied research work (AREW) was also shown.

2. The choice of research work (CReW) is one of the most important problems concerning the research work. Fig. 14 shows the functions of the choice of research work (CReW) as functions of local conditions (LC) and foreign conditions (FC). - local conditions are:

- raw materials sources (RMS);
- necessities (N),
- technical and organizational conditions (TOC);
- investment conditions (IvC).

The variants of raw materials sources were represented on fig. 3. Necessities (N) were represented as : demographic necessities (DN), industrial necessities (IN) and possibilities of export (PE). Technical organizational condition (TOC) comprises volume of research work (VReW), level of research work (LReW) and researchers (R). Investment conditions comprise (IvC): the problems of investments into plants (P), research work (RoW) and researchers (R). The later comprises:

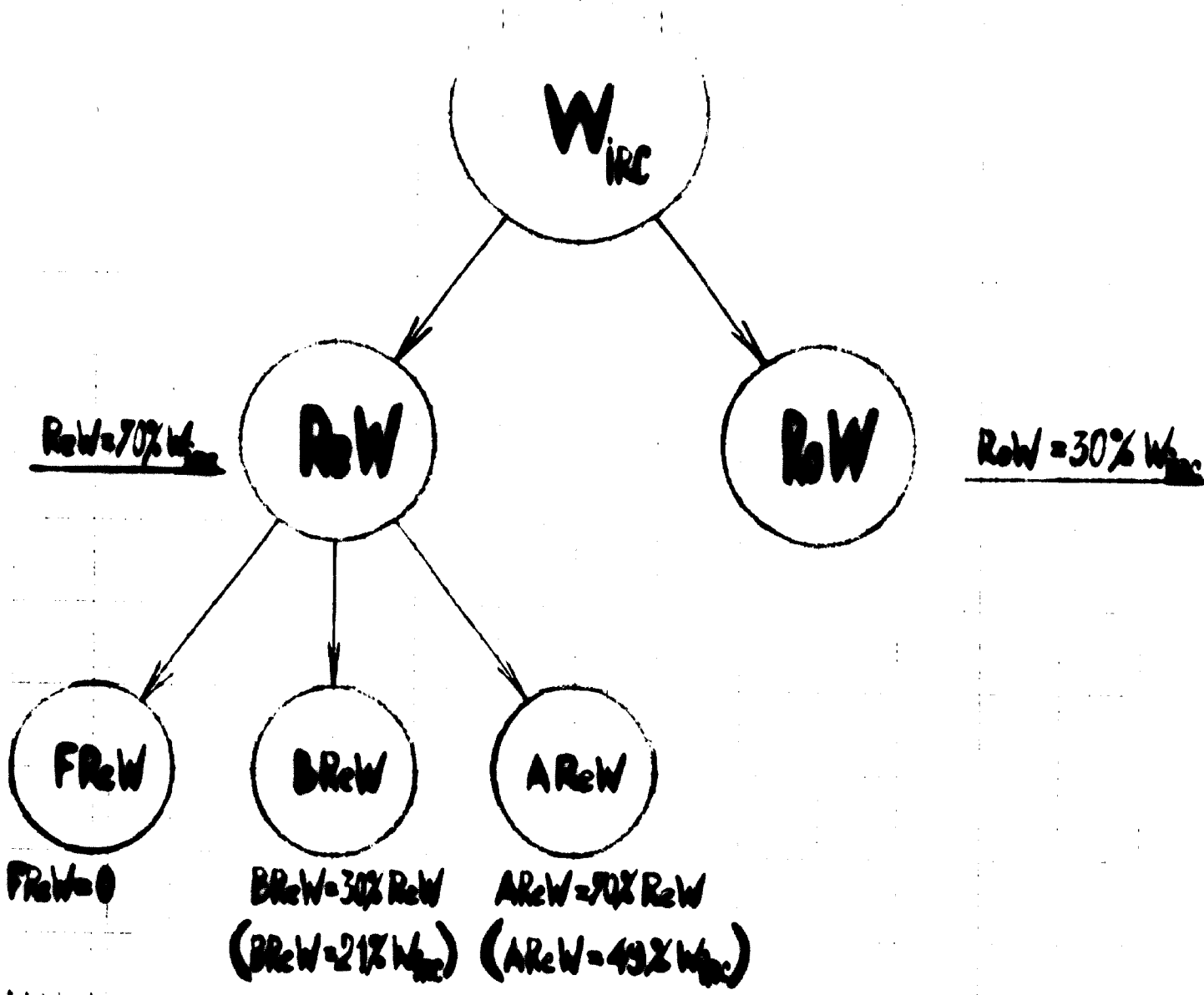


fig. 13a

Activities of an Industrial Research Centre

(W)

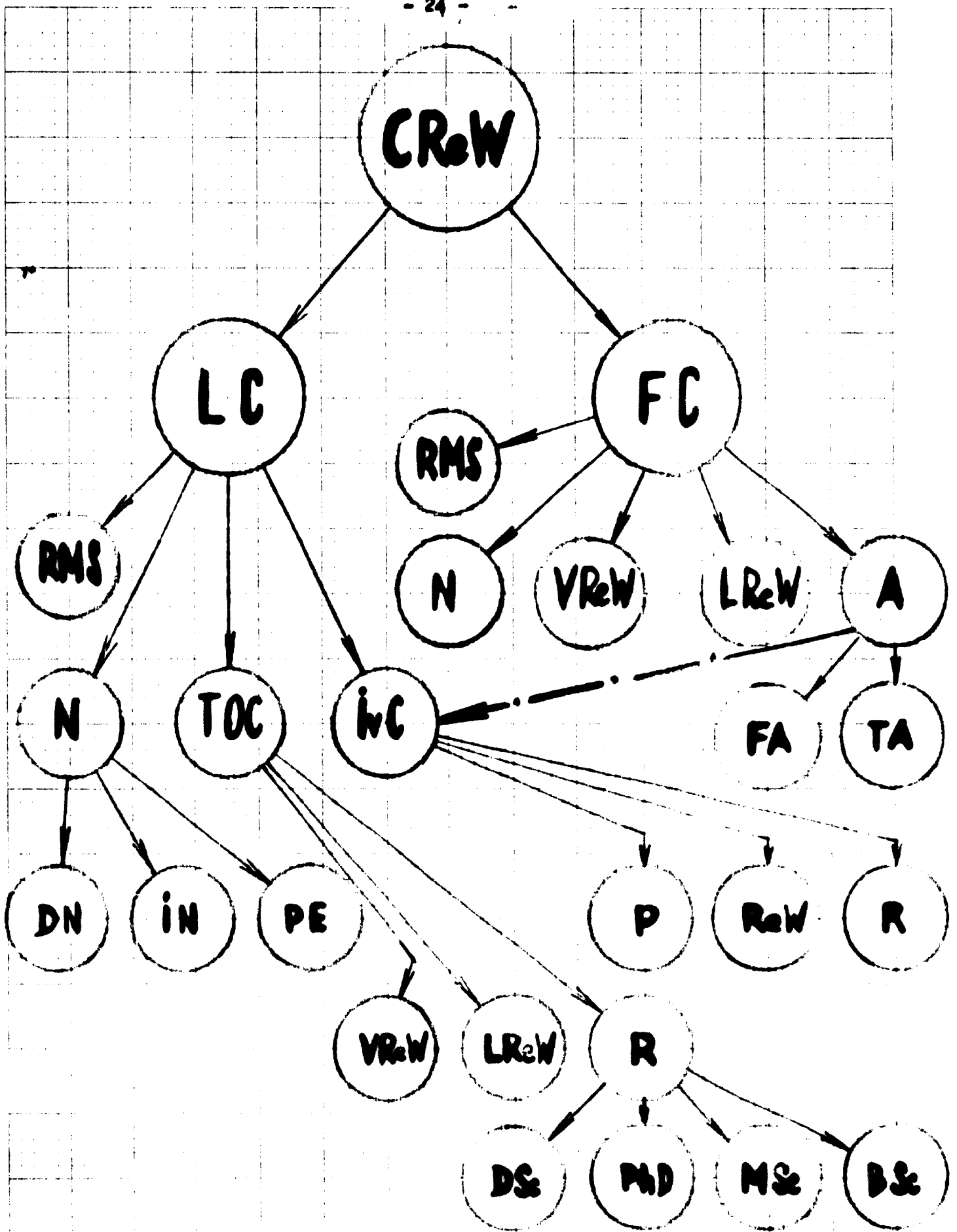


fig. 14:

$CRw = \emptyset (LC; FC)$

(LA)

doctors of sciences (DSc), philosophy doctors (phD), masters of sciences (MSc) and bachelors of sciences (BSc).

-Foreign conditions comprises of followings:

- raw materials sources (RMS);
- volume of research work (VReW);
- level of research work (LReW);
- necessities (N);
- assistance (A), which can be both financial assistance (FA) and technical assistance (TA).

As can be seen from this scheme, the problem of research work choice (CRew) is very complicated and delicate. One of the most important problems is the connection between local investment conditions (IvC) and foreign assistance(A).

3. Referring to the most important problems in the Building Industry, it will be discussed here the problem of research work (ReW) concerning the problem of technological processes (TP) and plants (P). Referring to the problem of research work, concerning the technological processes, there are two possibilities for consideration of this problem in the Building Industry (BI). This industry can be contemplated as one district composed from 3 above-mentioned fields: building materials prefabrication (BMP), building elements production (BEP) and building units production (BUP). Every technological process comprised in correspondent field can be considered as separate problems in its complete scope. This aspect (fig. 15) represents the classic conception of research work in the field of technological processes, concerning the Building Industry. In our opinion, it is possible to consider the Building Industry (BI) as one macro-field, composed from mezzo-fields : (BMP), (BEP) and (BUP).

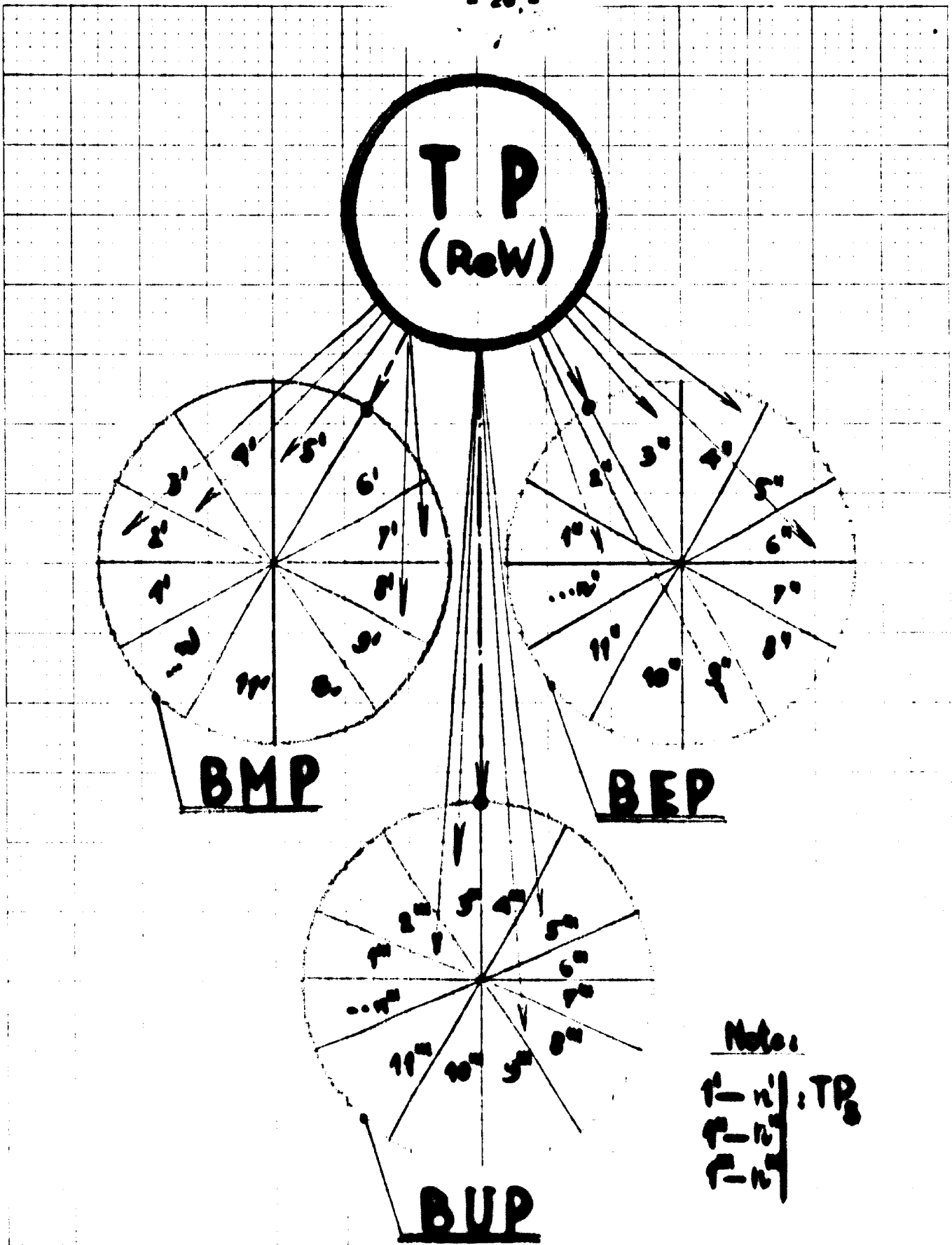


Fig. 13:

$ReW_{TP} = \phi(TR_3)$

(KA)

Every technological process (TP) can be represented as one micro-field. It is evident that such technological process (TP) comprises of physical change-unit operations, for which we proposed the term "unit operations points" (UOP), and chemical changes - unit processes, for which we proposed the term "Unit processes points" (UPP). It is very easy to see also, that in different technological processes (TP), in above-mentioned mezzo-fields of Building Industry (BI), exist the same unit operations points or the same unit processes points. In this way, it is possible to construct different virtual curves, which connects the same unit operations points and also different virtual curves, which connects the same unit processes points. These curves pass through many mezzo-fields comprised in the macro-field of Building Industry (BI). The correspondent terms were proposed by author for such points and curves, as followings:

- iso-operation point (IOP),
- iso-process points (IPI),
- iso-operation curve (IOC),
- iso-process curve (IIC).

This author's conception was shown on fig. 16.

4. The problem of Research Work in the field of plants (P) was represented on the scheme - fig. 17. This problem is concerning the following questions:

- a. plants for separate technological processes (TPs);
- b. plants for unit operations (UOP),
- c. plants for unit processes (UPP).

The problems of the plants under b and c comprise of:

- type of plants (T);

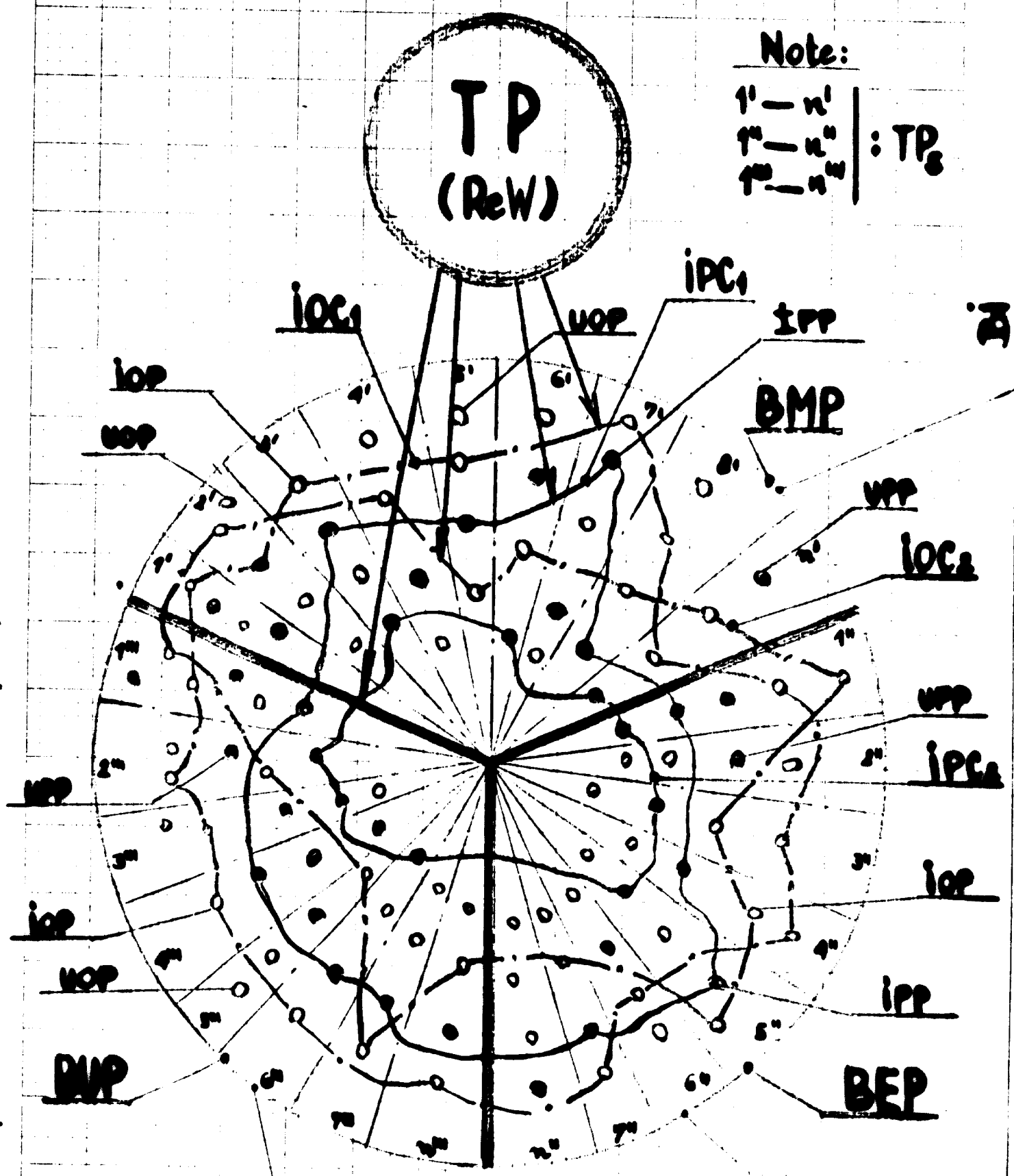


fig 15: $ReW_{TP} = \phi(ioc, ipp) = \phi(iop, ipp)$ (14)

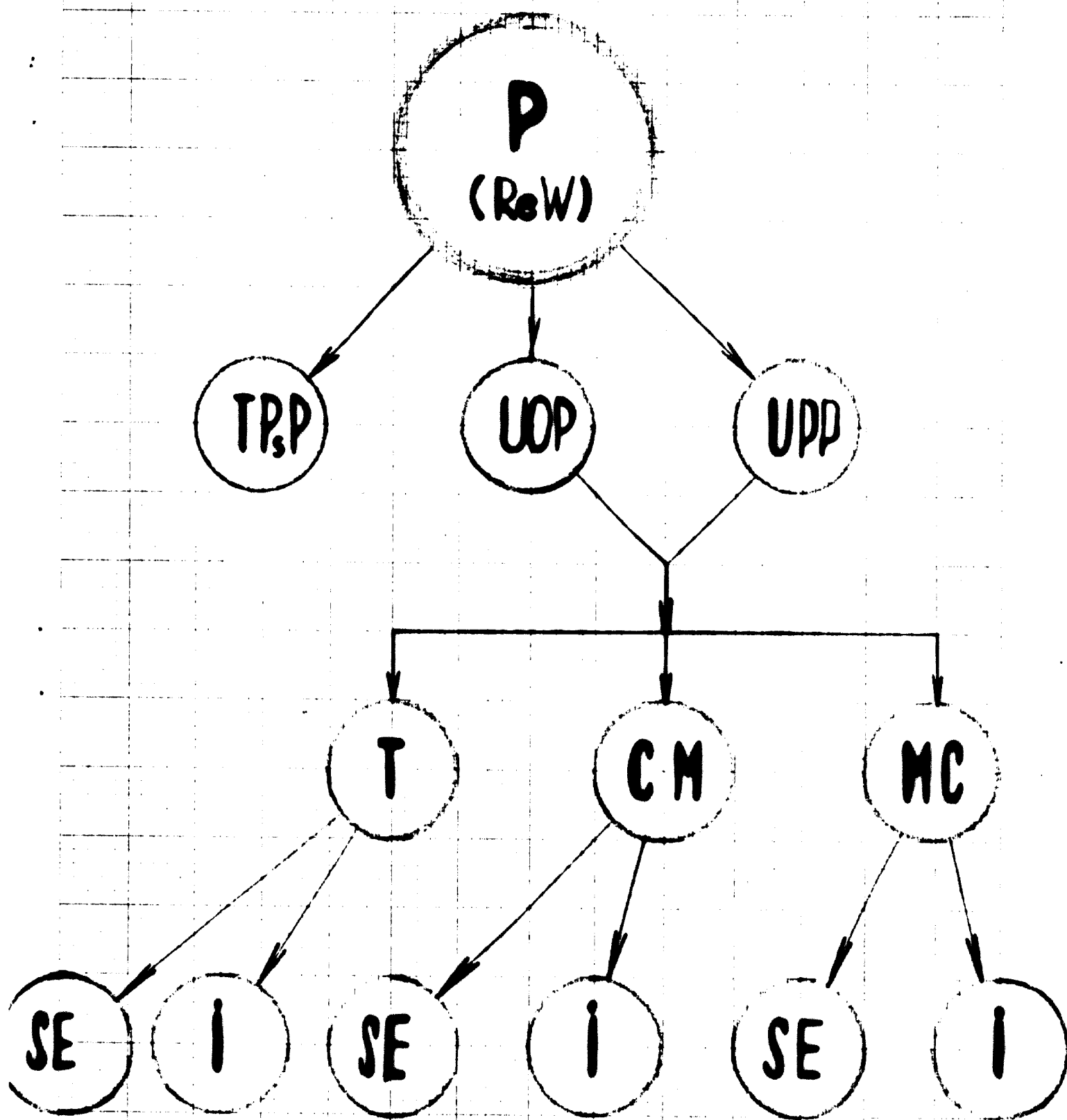


fig. 13 $ReW_p = \phi (TRP; UOP; UPP)$ (KA)

- construction materials (CM);
- methods of calculations (MC).

All of these problems comprise: survey of existing (SE) and improvement (I).

5. Fig. 18 represents a single general scheme of necessary researchers kinds, who will be engaged on the problems of Research Work in the Building Industry, concerning the fields of technological processes and plants.

6. Problem of researchers' permanent education (RPE) was considered by many authors in different countries. This problem can be, in our opinion, interpreted by means of one tensoric triangle, as it was shown on fig. 19. The influence in education must exist from every point of such triangle: University (U), Industrial Research Centre (IRC) and Researchers (R).

7. The problem of researchers is especially interesting and important for developing countries. In most cases, the researchers occupy themselves with the problems, which are interesting to them, independently from other researchers and organizations. Such a situation can be interpreted by means of singular points (fig. 20 a). The solution of this problem comprise of the connection of individual researchers singular points in a correspondent closed geometrical curve, closely connected with the Industrial Research Centre (fig. 20 b).

8. The problem of technology transfer (TT), from aspects of very great deal of authors, was considered as one problem, concerning phenomena, which can be interpreted as vectors (fig. 21 a). In our opinion, this phenomena can be realized as tensoric, under the conditions represented on fig. 20 b. This was represented on fig. 21 b and clearly shows the possibilities of technology transfer from developing countries (DC) to highly developed countries (HDC).

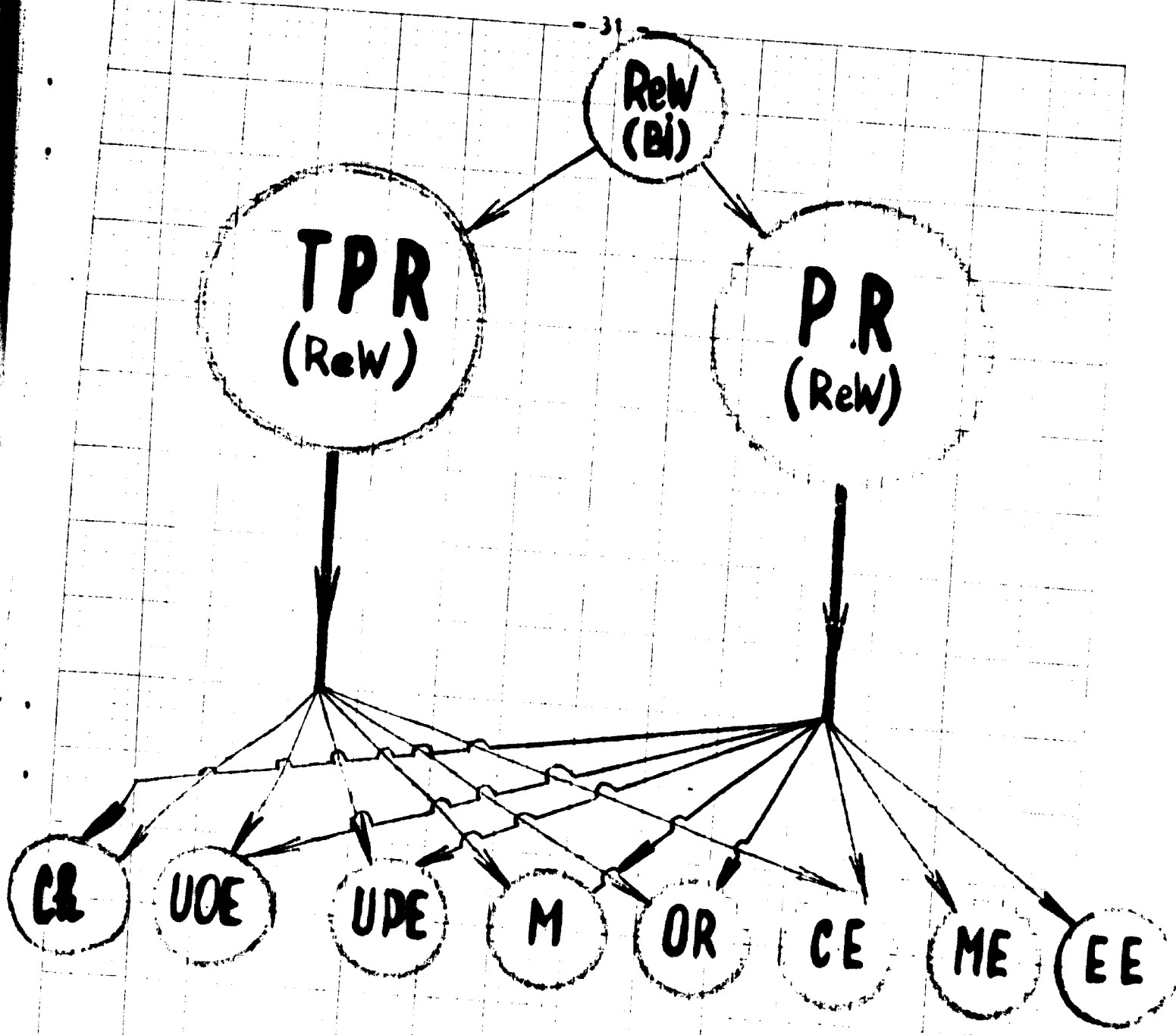


Fig. 10

$$\underline{\underline{TPR_{ReW} = \phi(Re)}}$$

$$\underline{\underline{PR_{ReW} = \phi(Re)}}$$

(V.A)

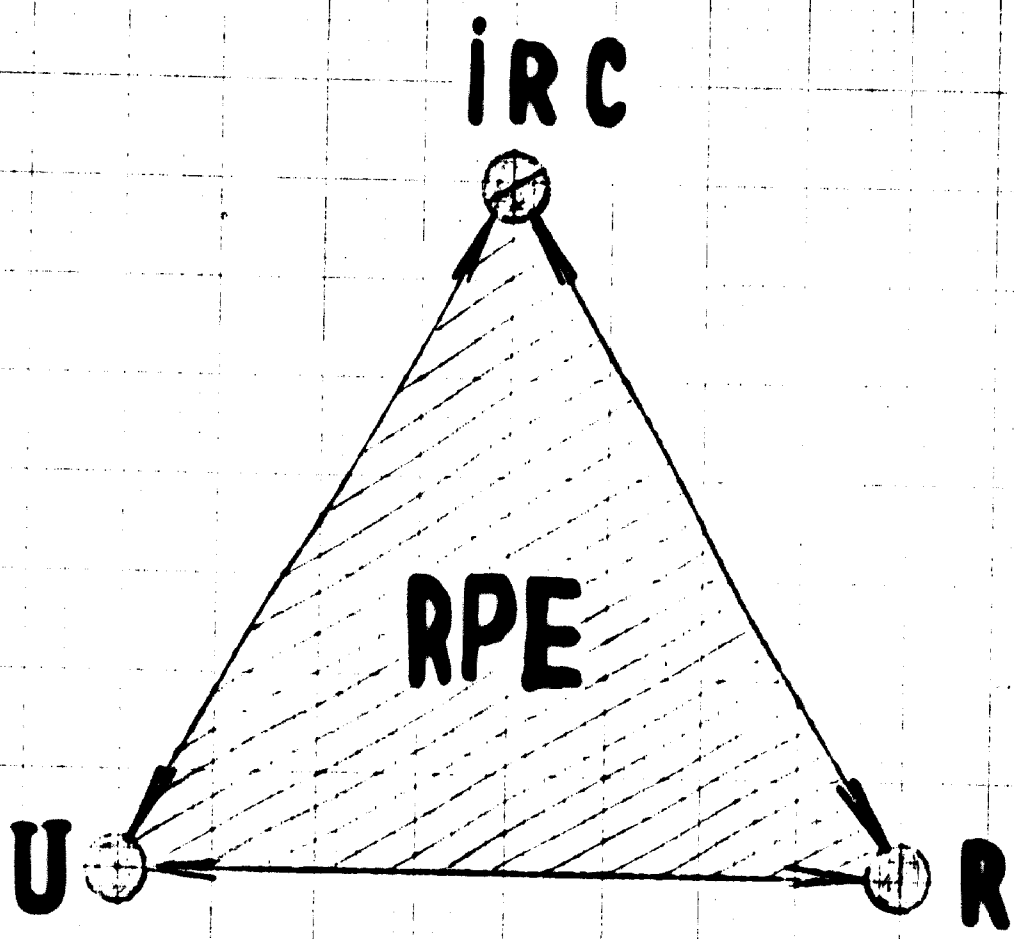
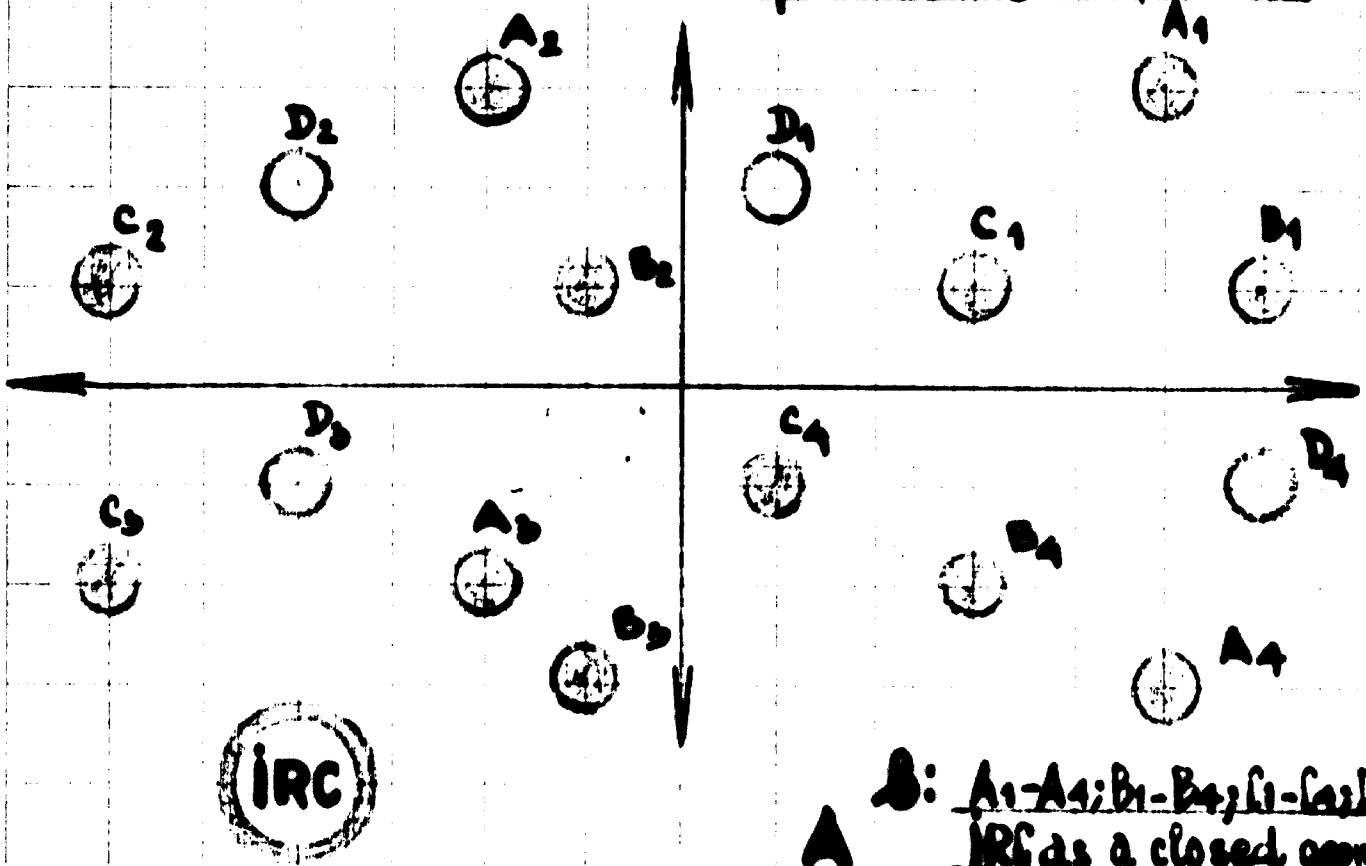


fig. 10: A tensoric triangle of the
researchers' permanent
education: $RPE = \phi(U, IRC, R)$

(VA)

a: $A_1-A_4; B_1-B_4; C_1-C_4; D_1-D_4$
IRI as separate research
points (singular points)



b: $A_1-A_4; B_1-B_4; C_1-C_4; D_1-D_4$
IRI as a closed geometrical
curve

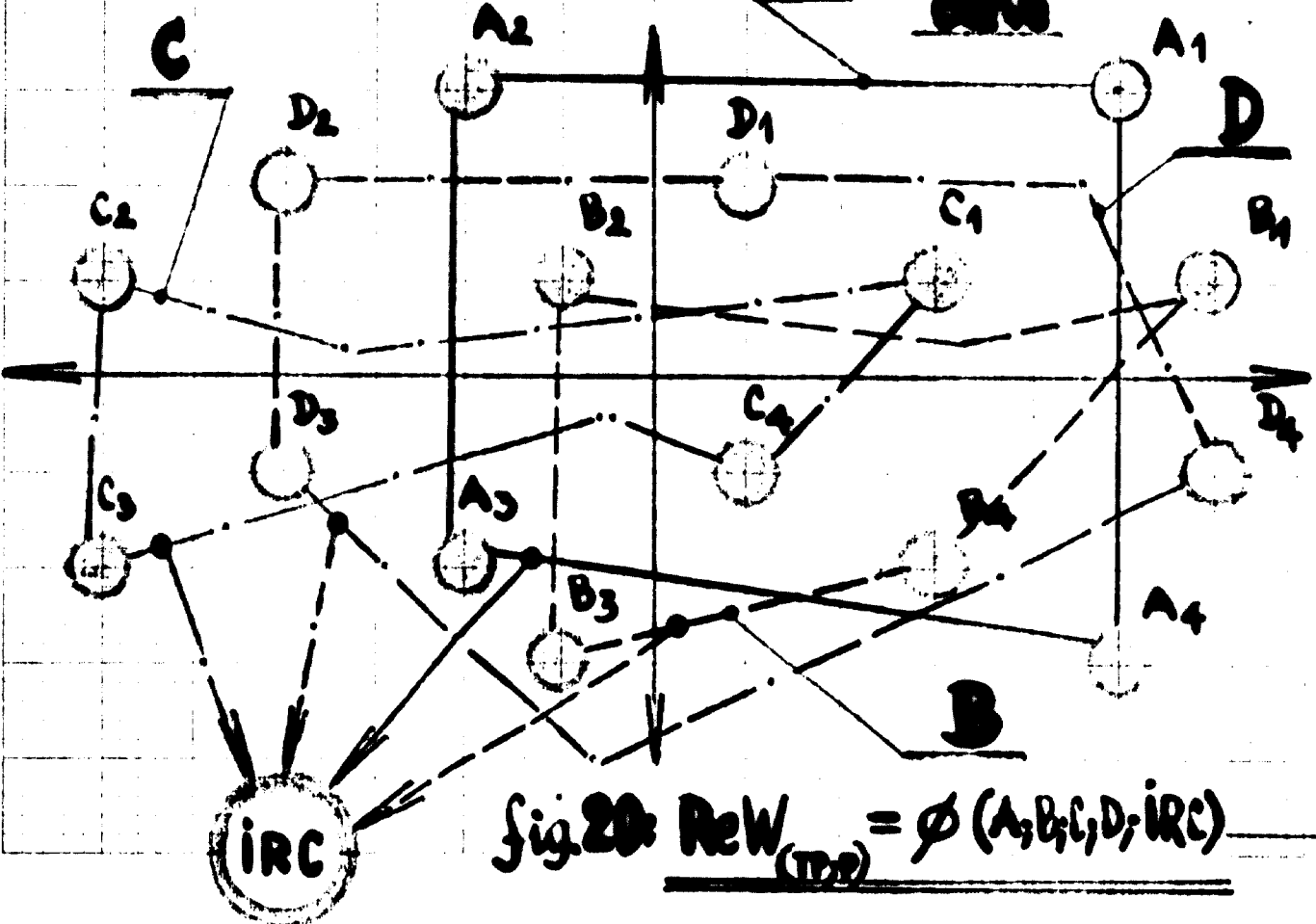
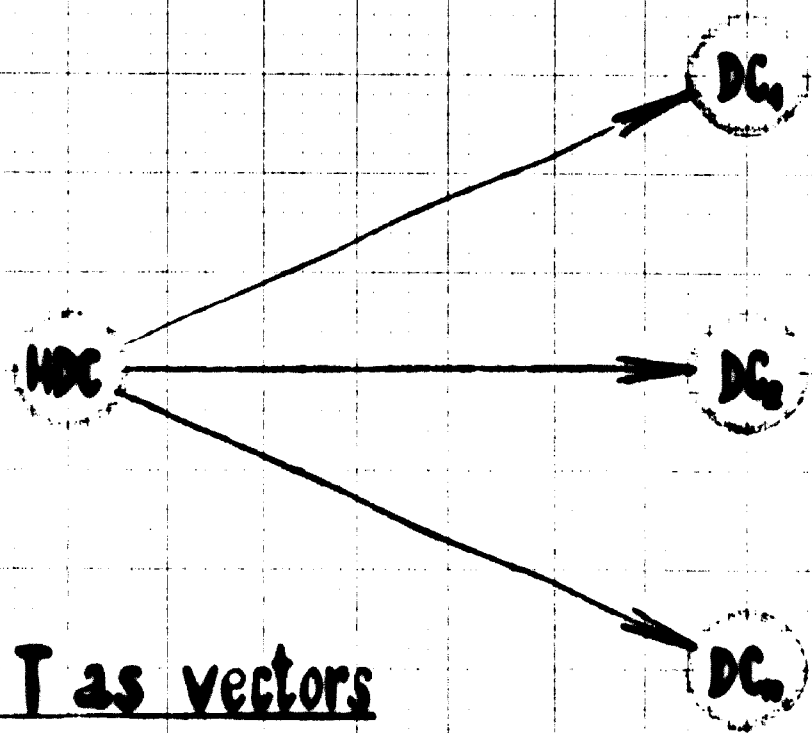
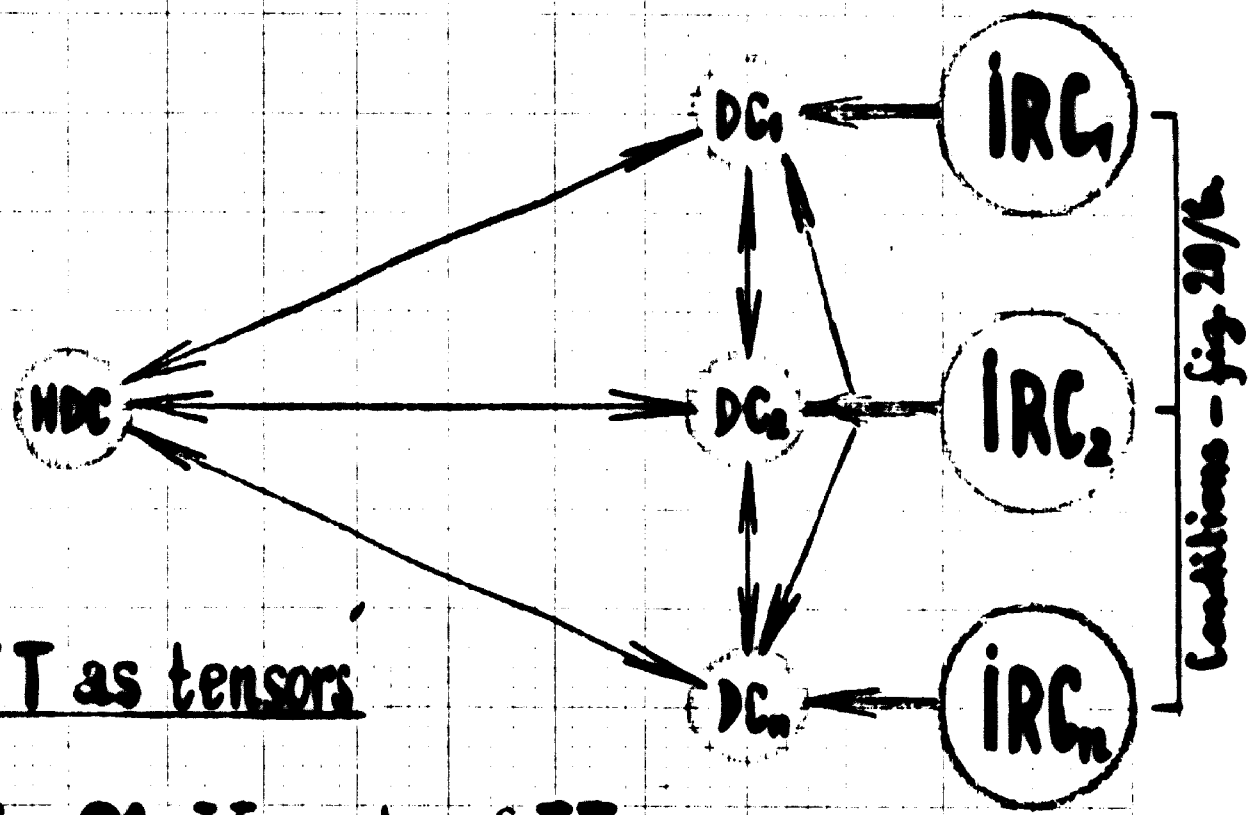


fig 20: $ReW_{(IRI)} = \phi(A, B, C, D, IRC)$ (10)



a: TT as vectors



b: TT as tensors

fig. 21: Variants of TT (K)

9. The problems of Research Work methods are also very interesting in the scope of basic problems in the Research Work in the field of the Building Industry. Fig. 22 represents the common methods and method of mathematical modelling which cover the most important districts interesting for Research Work in Building Industry. On fig. 23 a procedure of analytical approach was represented.

10. Any other problems interesting for Research Work in Building Industry will be discussed in one of the coming considerations in this Study.

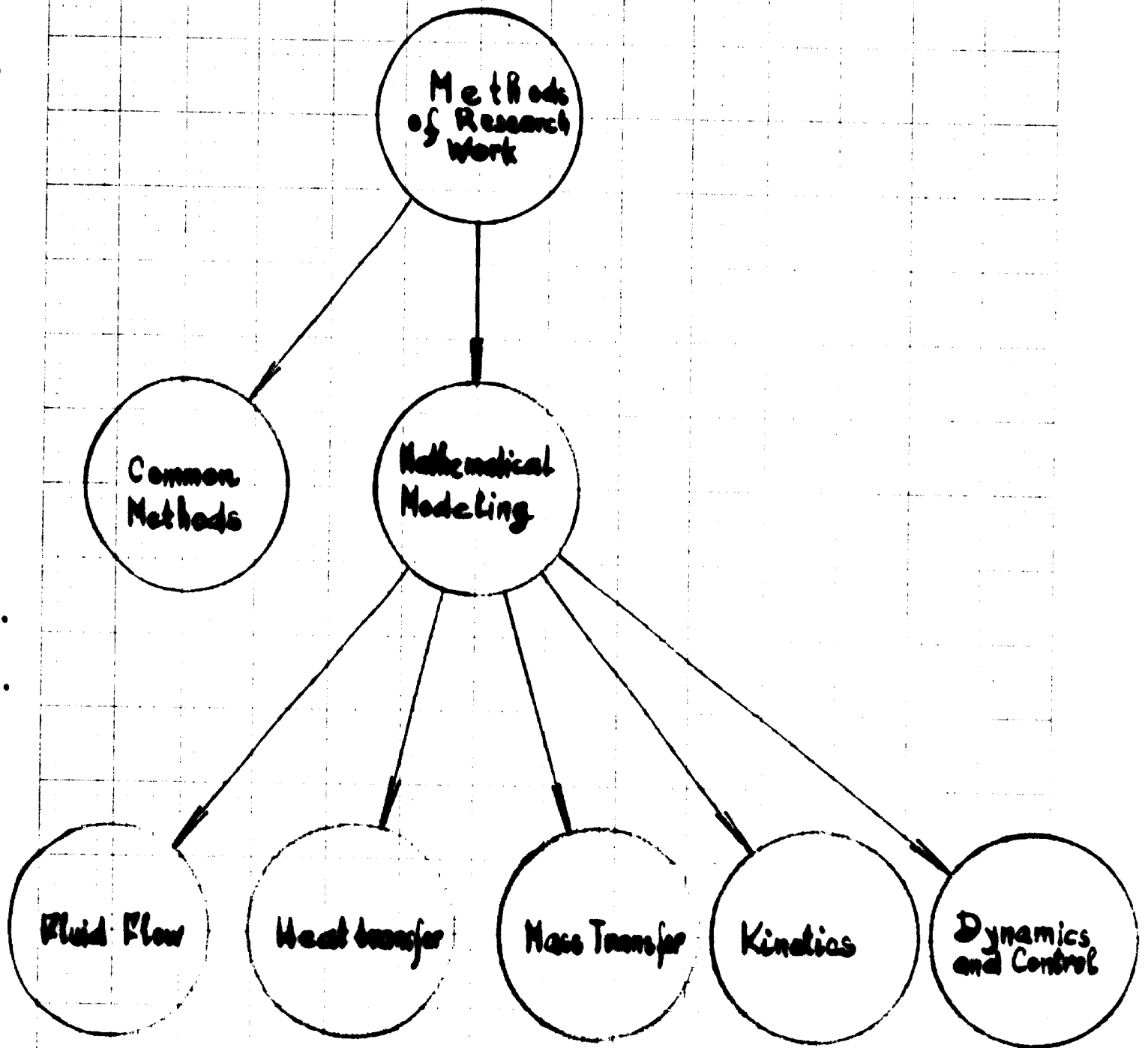


Fig. 22: Methods of research work in Building industry (10)

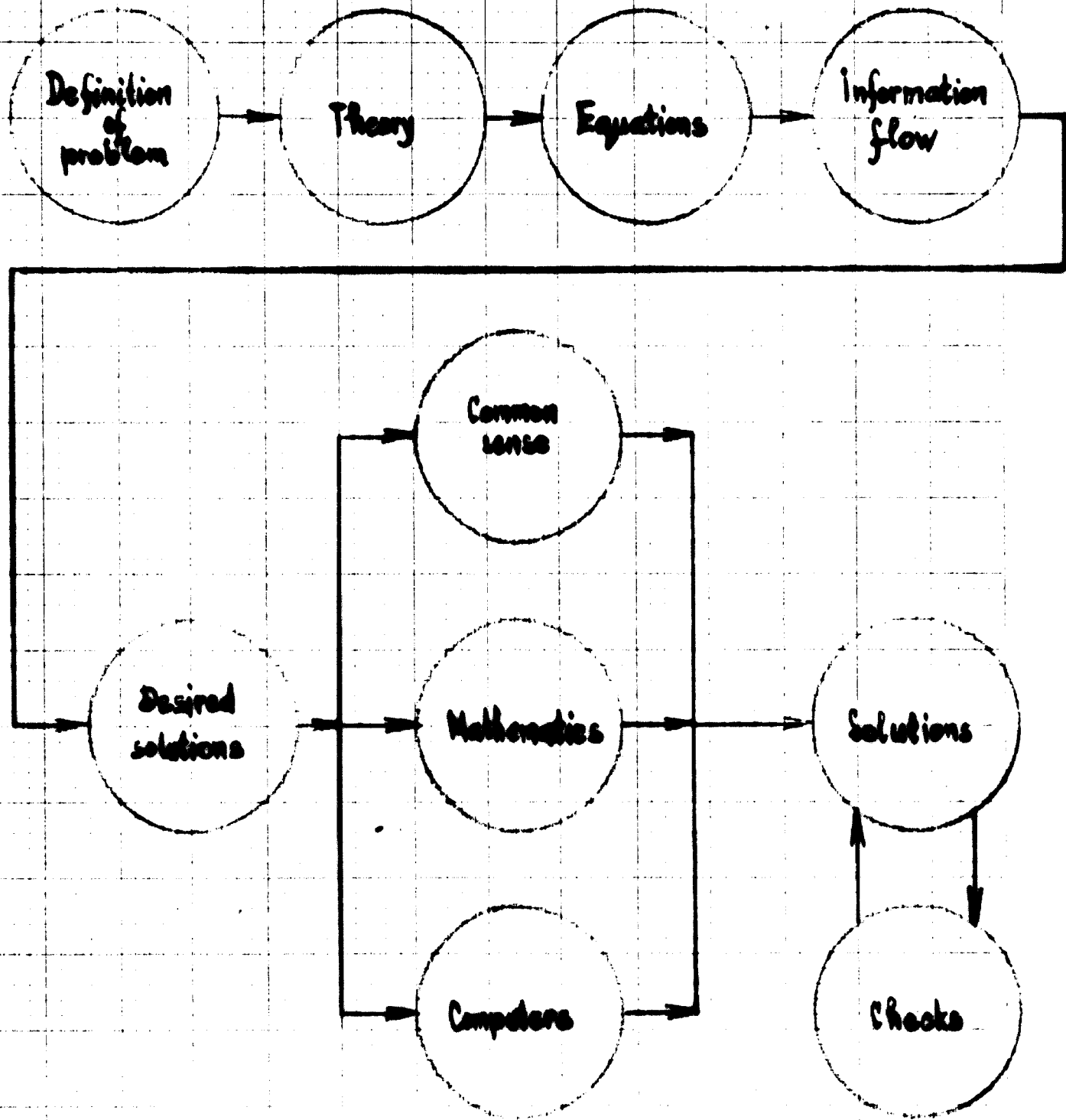


Fig. 2 Procedure for Analytical Approach

Roger G.E. Franks: Mathematical Modeling in Chemical Engineering, John Wiley & Sons, Inc., New York, 1968

IV THE PROPOSAL-CONCERNING RESEARCH WORK IN THE FIELD OF BUILDING INDUSTRY

1. Fig. 24 represents the scheme of Building Industry (BI), in the Libyan Arab Republic. This scheme was performed following the previously mentioned general conceptions and theses concerning Building Industry. The most important micro-fields in the scope of correspondent mezzo-fields were represented. Special attention was paid to the problem of raw materials sources. These data were also given on the scheme and at the same time, the possibilities of correspondent productions were represented. As we can see, there are many objective possibilities of different productions, based on the local raw materials and in combinations of local raw materials with imported raw materials.

2. The proposal, concerning Research Work in the field of Building Industry in Industrial Research Centre, Tripoli - L.A.R., was represented as scheme, on fig. 25. The basic research work (BRW); in our opinion, would be very interesting on the problems represented on fig. 16. This means, Research Work of such kind would comprise of the basic problems, concerning the questions of iso-operations points, iso - processes points, iso - operations curves and iso - processes curves. These problems are generally open and they represent very interesting and very important fields both from technical and economic aspects. The application of the modern research methods is especially important for Research Work of these fields. Applied Research Work (ARW), from our aspects, would be concentrated on the problems of technological processes (TP), mathematical modelling (MM) and plants (P). The ways of the Research Work in this district were also represented on the scheme. For the questions of technological processes, the aspects concerning unit operation and unit processes are particularly important. The phenomena, which can be covered by means of mathematical modelling applications, were also represented on the scheme.

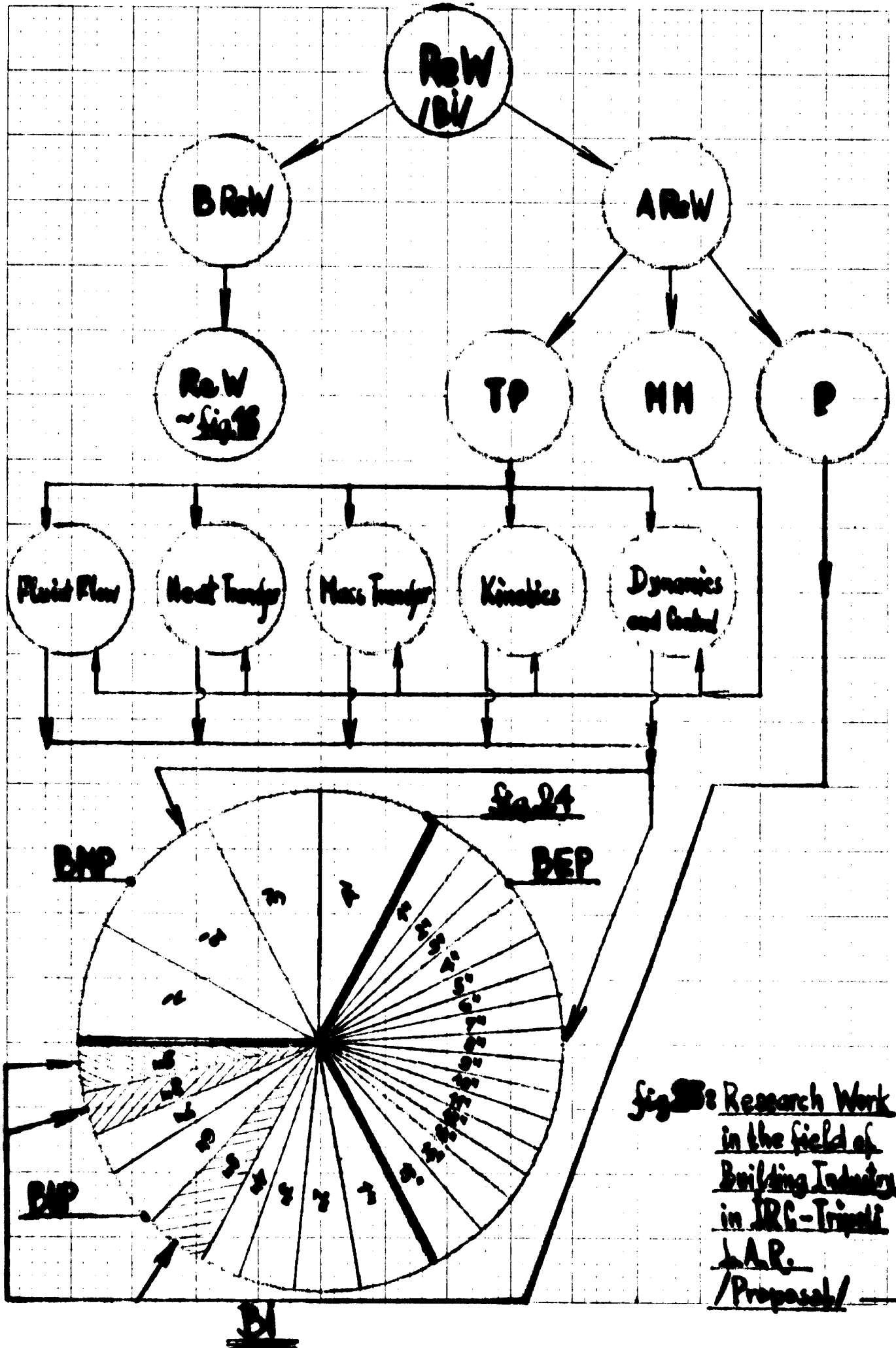


fig 13: Research Work
in the field of
Building Industry,
in IRC-Tripoli
L.A.R.
/Proposed/

These phenomena are:

- fluid flow;
- heat transfer;
- mass transfer;
- kinetics;
- dynamics and control.

In the field of building units production (BUI), three very interesting kinds of building units were given as following:

- trailers units and trailers colonies;
- water cooling towers
- tourists building.

3. The question of trailers - units and trailers-colonies, in our opinion, is very interesting and important for the Libyan Arab Republic by reason of very great perspective of the next phase of industrialization. Many factories would be constructed on different places of this country and the problem of the people, who will be engaged in these factories construction, is more than evident. In such cases the application of trailers - colonies, with trailers - units would be undoubtedly suitable. It is very important to underline that the problems of energy and water supplying, which is necessary for the people, would not be difficult because the plants for such supplying would be installed as special separate trailers units or energy and water would be provided from the sources foreseen for the factories themselves.

4. The proposal for water - cooling towers was given, concerning the great important question of water supplying. With the intensive increasing of industrial and energetic plants

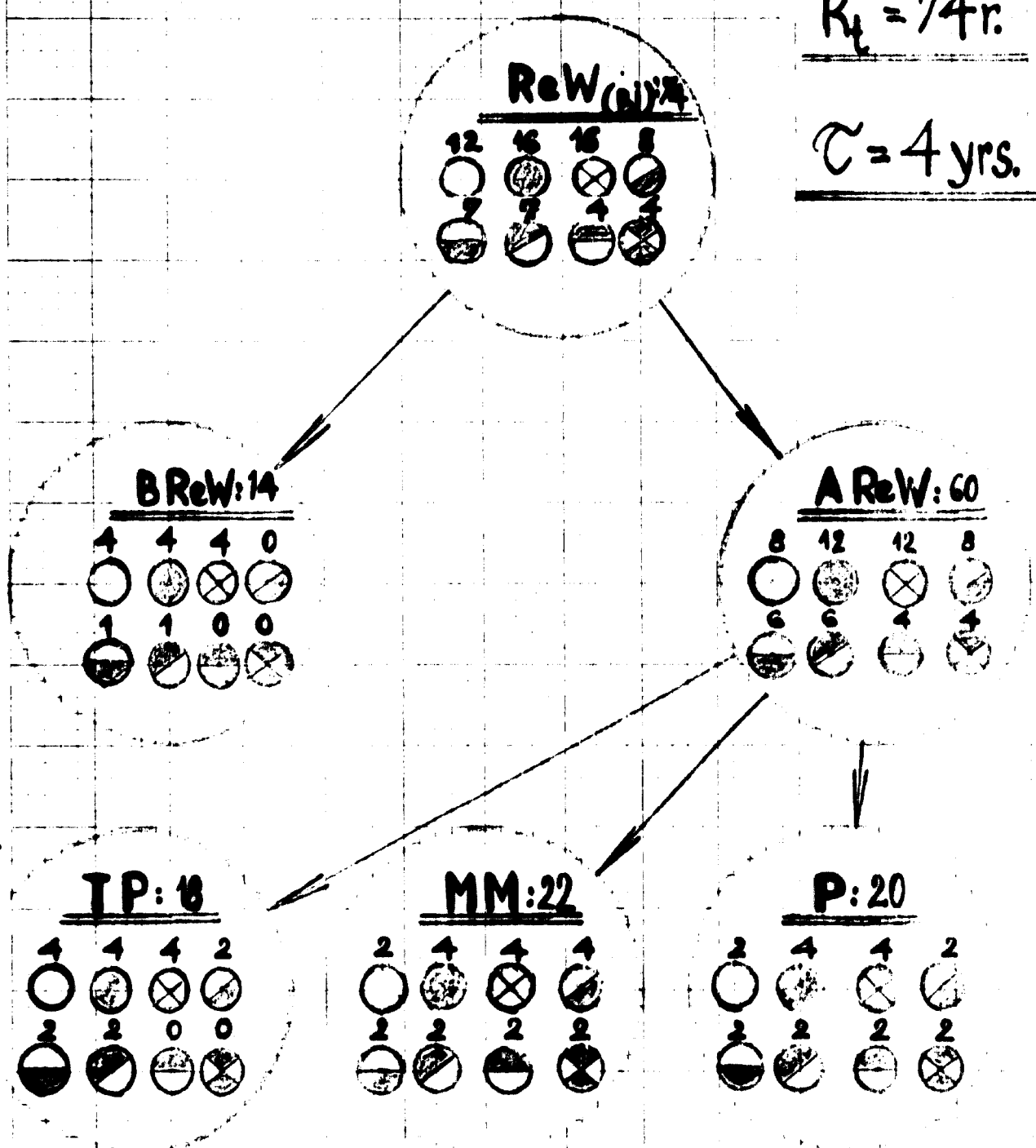
volume, the problem of water supplying systems becomes very important, both from technical and economic aspects. It is necessary to join the increasing sanitary plants (air condition plants) volume to previously mentioned increasing of industrial and energetic plants volume. Many very serious studies, concerning the problem of water supplying, were published. The water generally represents one of the most important problems in our present world and for the future time. From the technical and economic aspects, with dispossable technical solutions, the applying of recirculating systems is the most suitable.

5. The Libyan Arab Republic, in our opinion, is one country, which has very suitable conditions for development of tourism. There are especially very interesting sights (e.g. Leptis Magna and Sabratha) and very beautiful places, which generally are very attractive for the tourists from different countries. Such touristic possibilities undoubtedly indicate the necessity of adequate touristic buildings (hotels) constructions.

6. On the fig. 26, fig. 27, fig. 28 and fig. 29, the questions of researchers, necessary for Research Work in the field of Building Industry (BI), were considered. As it is visible from fig. 28, the total number of necessary researchers is: 74 researchers for the one foreseen period of 4 years. The necessary levels of researchers are following:

- doctors of philosophy (pHD) : 7;
- masters of sciences (MSo) :
- or masters of engineering (ME): 25;
- bachelors of sciences (BSo) :
- or bachelors of engineering (BE): 42;

$R_t = 74r.$
 $C = 4 \text{ yrs.}$



Qualifications:

- | | | | |
|---|-----|---|----|
| ○ | CR | ⊖ | OR |
| ⊙ | UOE | ⊗ | CE |
| ⊗ | UPE | ⊙ | ME |
| ⊖ | M | ⊗ | EE |

NOTE:
See fig.18;251

fig.28: Researcher in the field of **Bi** problems
/Proposal/

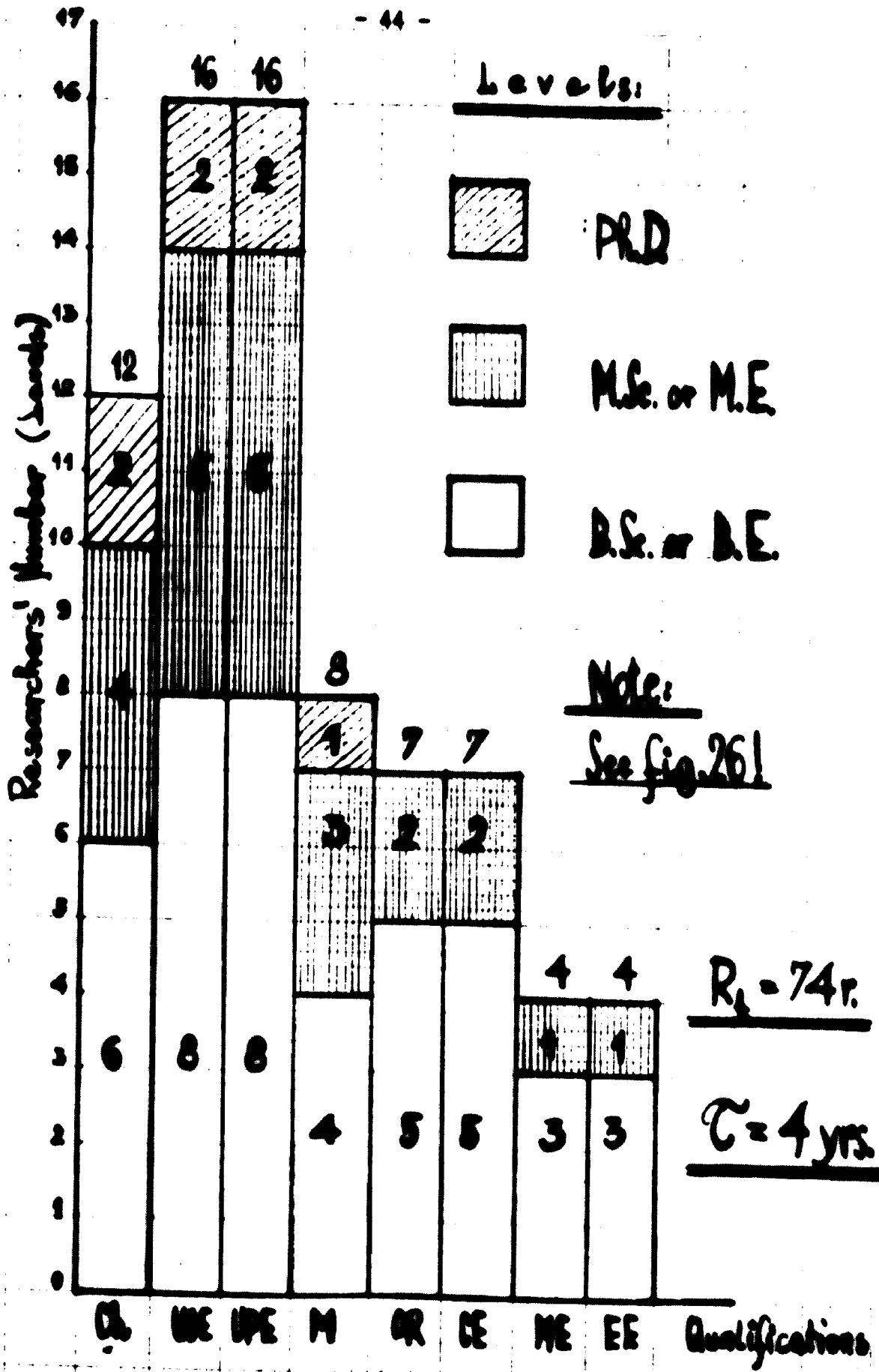


fig. 27 Levels of researchers in the field of B problems / Proposal

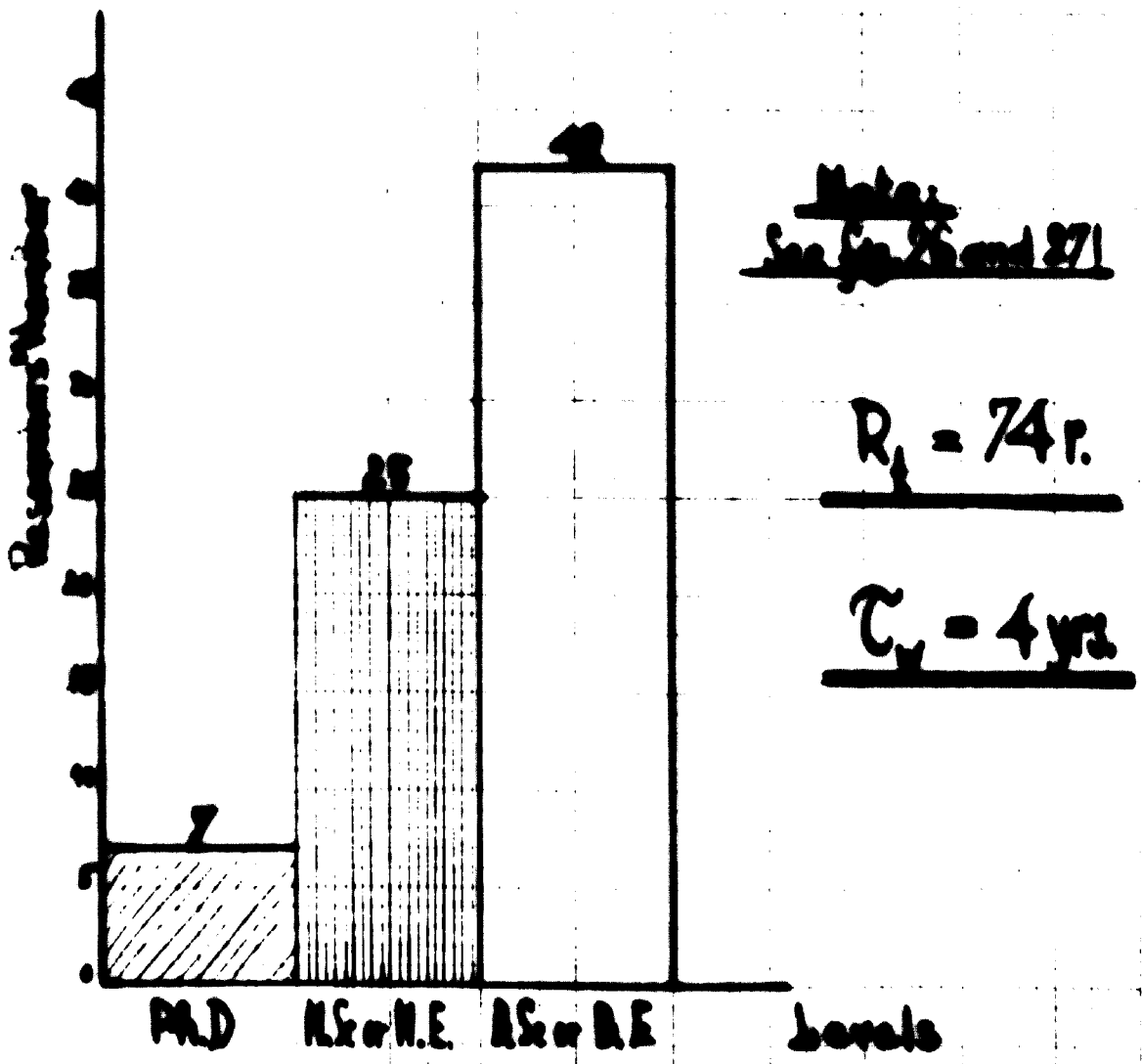
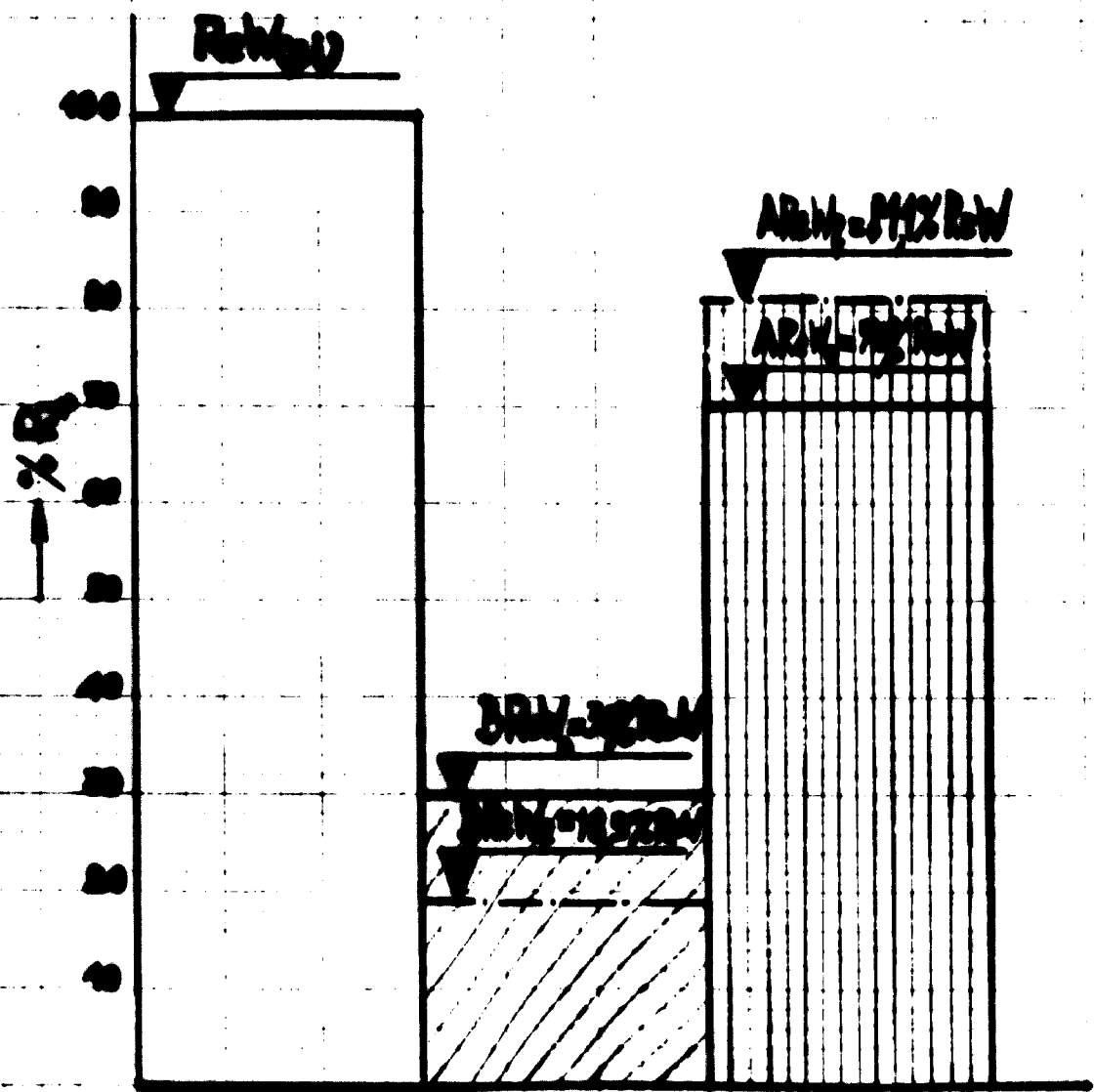


Fig 28: Levels of researchers in the field of AI problems / Proposal / (K.A)



NOTE:

- 1. $BRW = 14/74 = 18.9\% R_2$
- 2. $ARW = 60/74 = 81.1\% R_2$
- 3. See Fig. 25!
- 4. forecast
- 5. optimal

Fig. 25: Relationship Between BRW and ARW in the field of problems Annual

As it is visible from fig. 29, the foreseen percents of basic research work (BRW) and applied research work (ARW), are minor than the correspondent optimal percents of these works, generally foreseen for Industrial Research Centres. This is the consequence of the considered Research Work period and researchers. In our opinion, the foreseen percents are real for one considered period of 4 years. The numbers and the levels of researchers are the most important problems, concerning the Research Work in the field of Building Industry (BI). In our opinion, it is possible to solve these problems in the following way: by engagement of local dispossable experts and by simultaneous engagement of adequate researchers from different countries. This would be one realistic solution of the problems in the first steps of frontal research work starting.

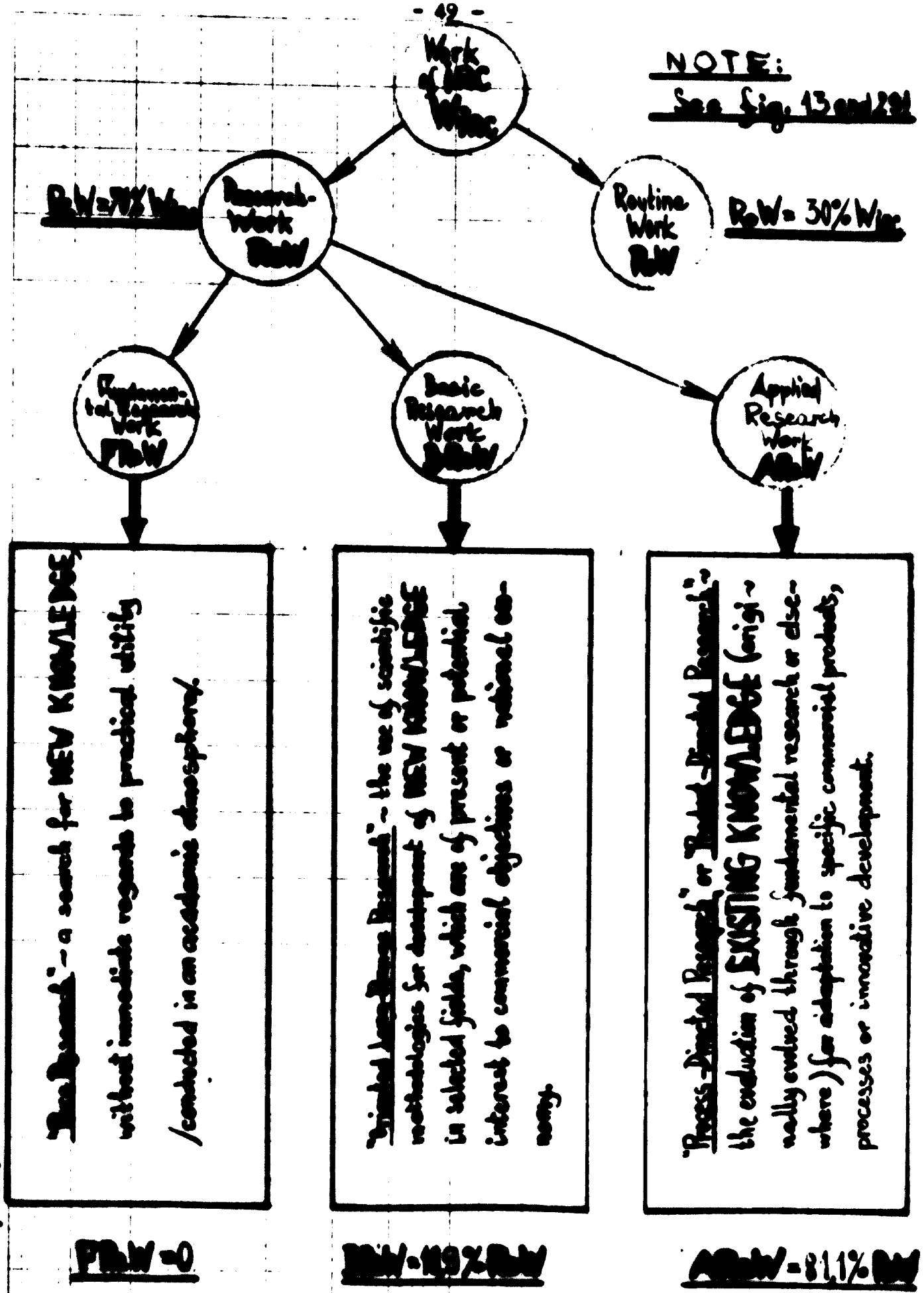
V DISCUSSION - CONCERNING THE PROBLEMS OF RESEARCH WORK AND WORK ORGANIZATION

1. The problems of Research Work (ReW) in the field of Building Industry (BI), were shown on different schemes in previous parts of the Study. On fig. 30, the scheme of Research Work scope was represented.

2. From the aspects of Work Organisation in Research Work, the question of Research Work Model (MReW), is especially interesting. This model was shown on fig. 31 as function of: model of problem (MP), model of solution (MS) and model of researchers (MR). This scheme represents such model as tensoric triangle. As it was shown on fig. 32, model of problem (MP) comprises of: model of tangential approach (MTA), model of parabolic approach (MPA) and model of problem definition (MDP). Model of solution (MS), as it was shown on fig. 33, comprises of: quality model (MQ), speed model (MSp) and price model (MPr). The most interesting problems are the models comprised in the quality model, as the followings: improvement (I), innovation (In) and creation (Cr). The model of researchers (MR), as it was shown on the fig. 34, comprises; of two models - model of levels (MLe) and model of experience (MEs). The necessary researchers levels were indicated previously. In the concrete conditions, for the first Research Work period, the levels of doctors of sciences (DSc), in our opinion, are not indispensable. The adequate experience is very necessary and important for Research Work and one orientation to the experts from different fields in Building Industry, in the scope of the decision concerning the researchers choice, is very suitable.

3. The scheme of the model of Work Organisation in Research Work (MWO_{ReW}), was represented on the scheme - fig. 35. This model comprises of two models: work fortification (WF) and work strategy (WSt), which have as result model of efficiency in Research Work (MEF_{ReW}). The problem of optimization of this

NOTE:
See Fig. 13 and 29



RW = 77% W

RW = 30% W

"Pure Research" -- a search for **NEW KNOWLEDGE** without immediate regards to practical utility /conducted in an academic atmosphere.

FDW = 0

"Directed Area-Research" -- the use of scientific technologies for development of **NEW KNOWLEDGE** in selected fields, which are of present or potential interest to commercial objectives or national economy.

BRW = 19% RW

"Process-Directed Research" or "Product-Directed Research" -- the evolution of **EXISTING KNOWLEDGE** (originally evolved through fundamental research or elsewhere) for adaptation to specific commercial products, processes or innovative development.

ARW = 81.1% RW

Fig. 28 Relationship among FDW, BRW and ARW in the field of Systems / Process

(14)

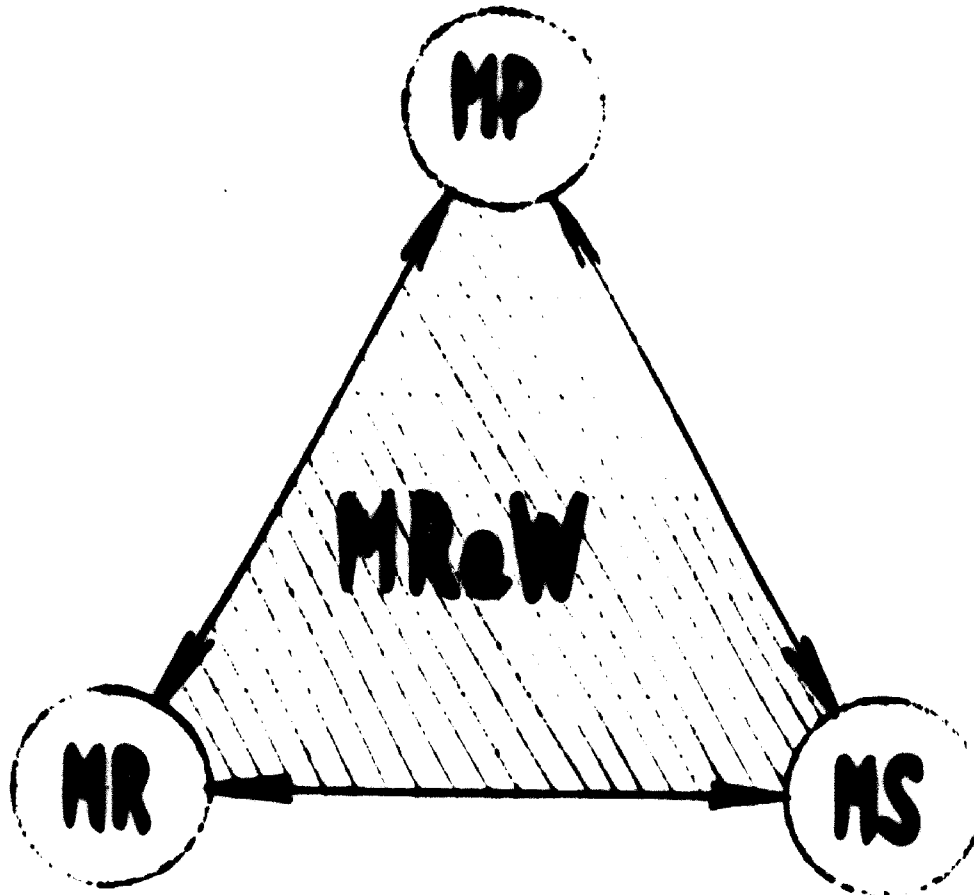


fig. 31: MRew as a tensoric triangle:

$$\underline{\underline{MRew = \phi(MR, MS; MR)}}$$

(14)

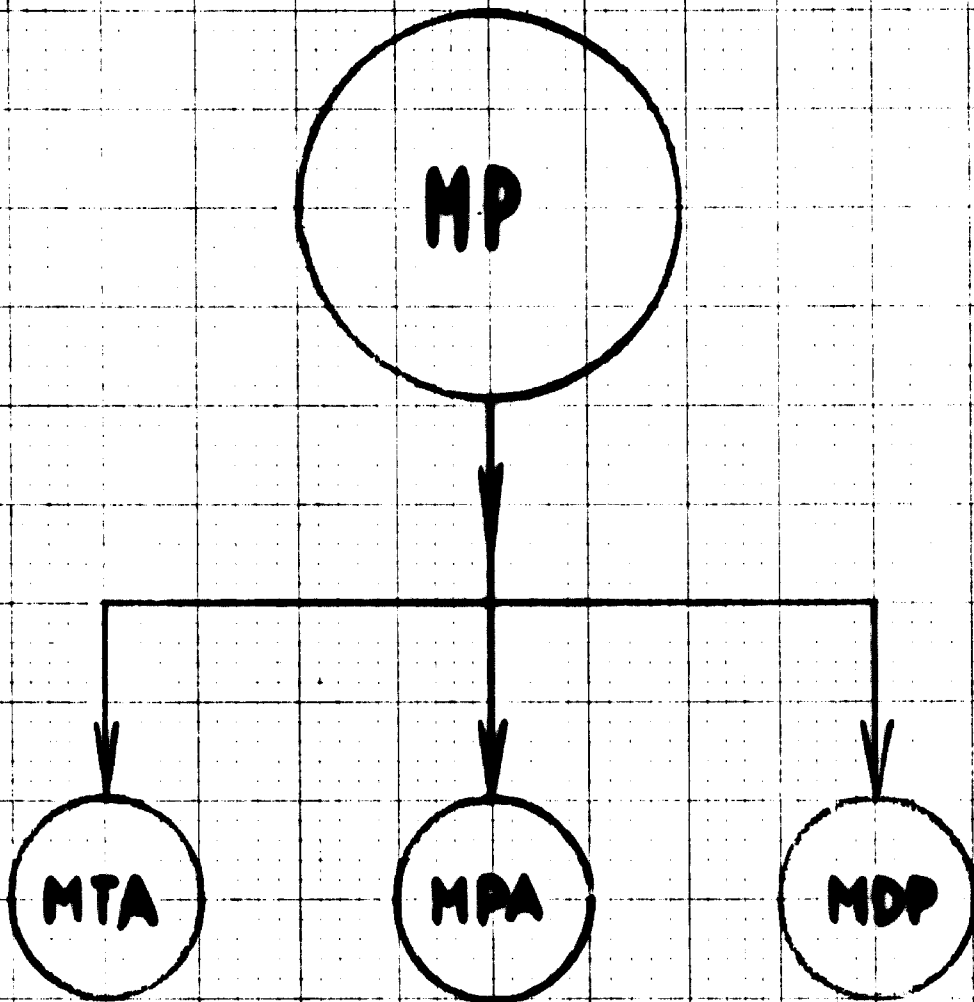


fig. 32: $MP = \emptyset(MTA; MPA; MDP)$ (10)

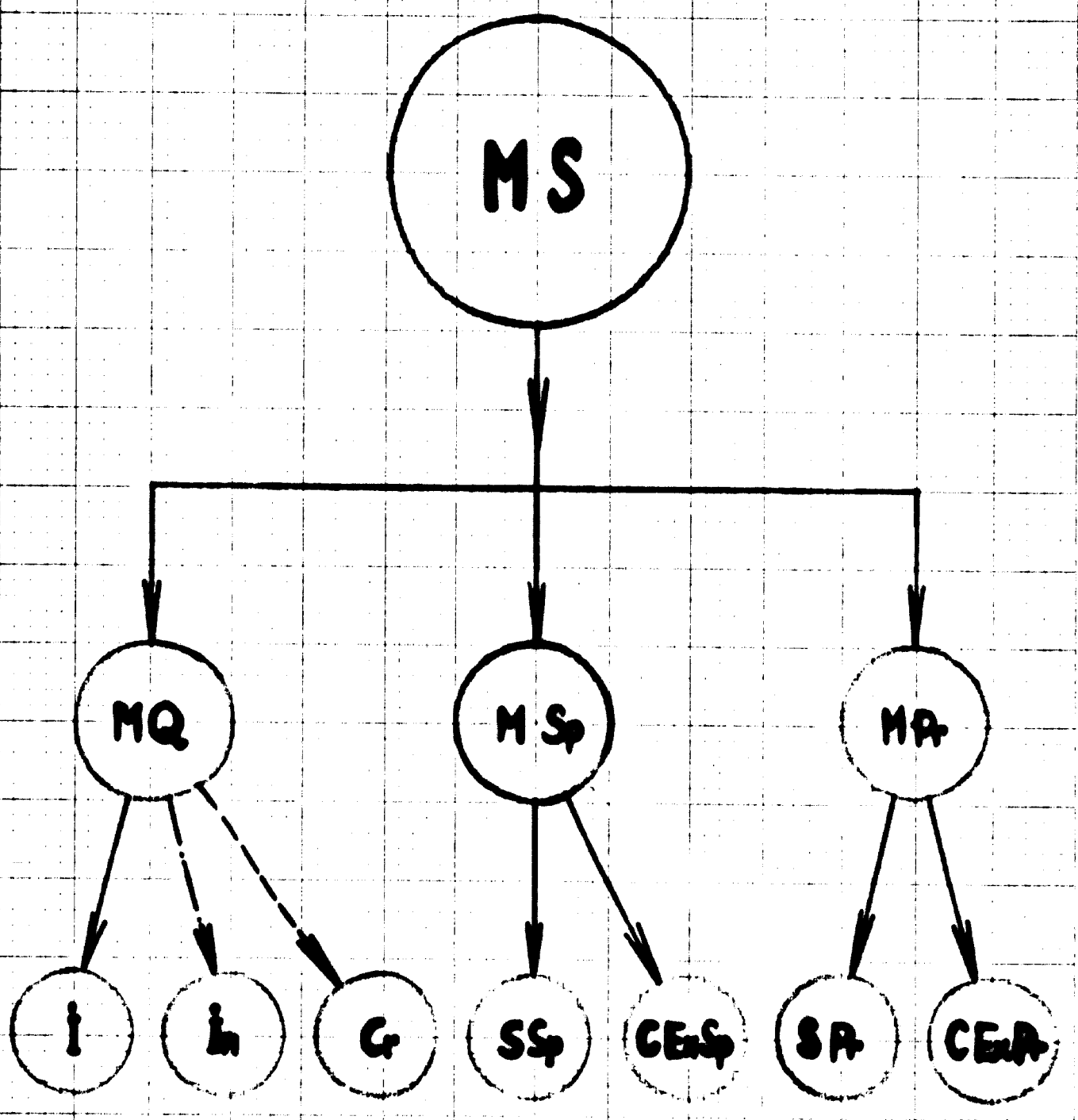


fig. 33: $MS = \emptyset(MQ; MSp; MA)$

(14)

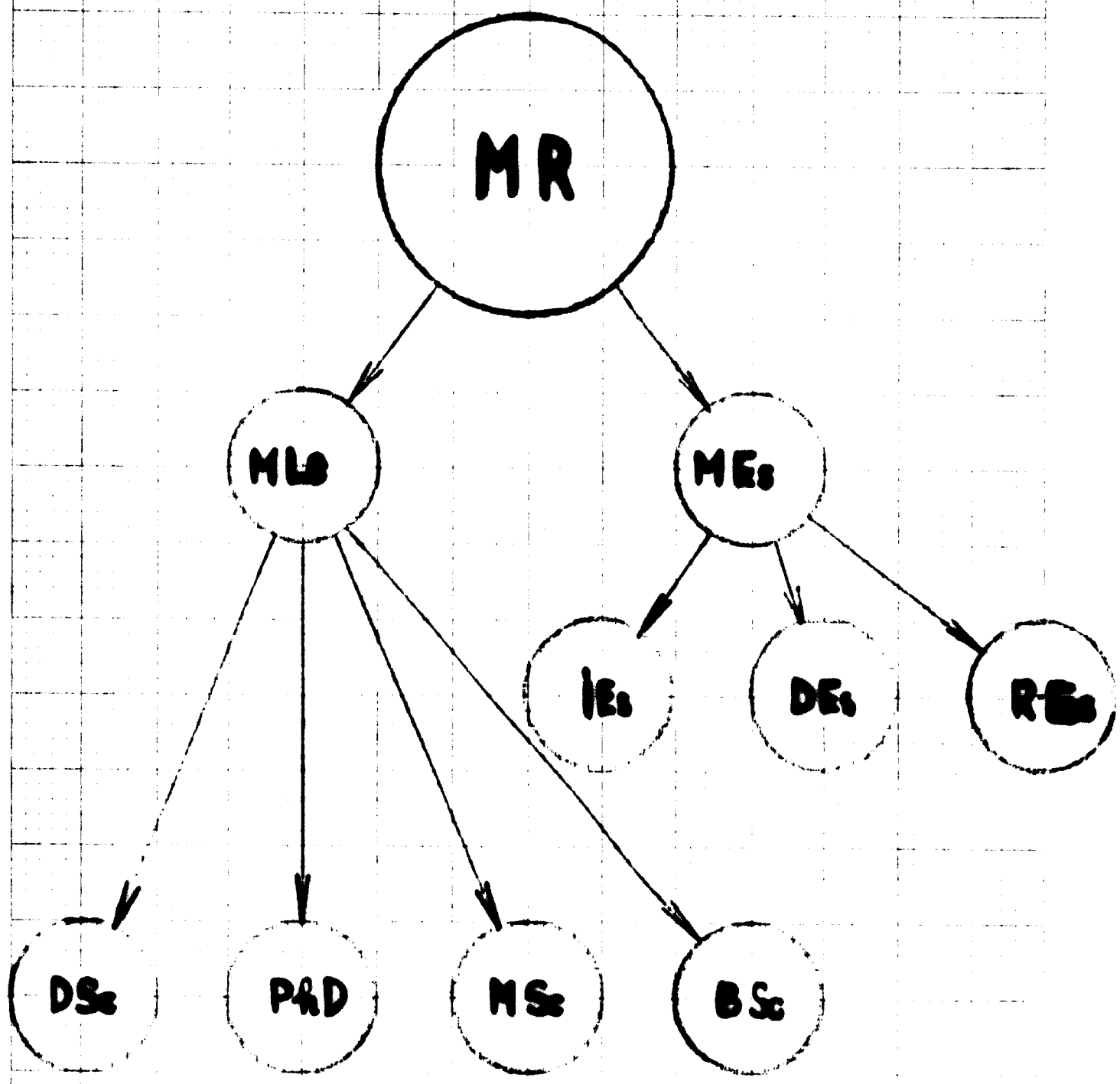


fig. 34: MR = \emptyset (MLs; MEs) (v.A)

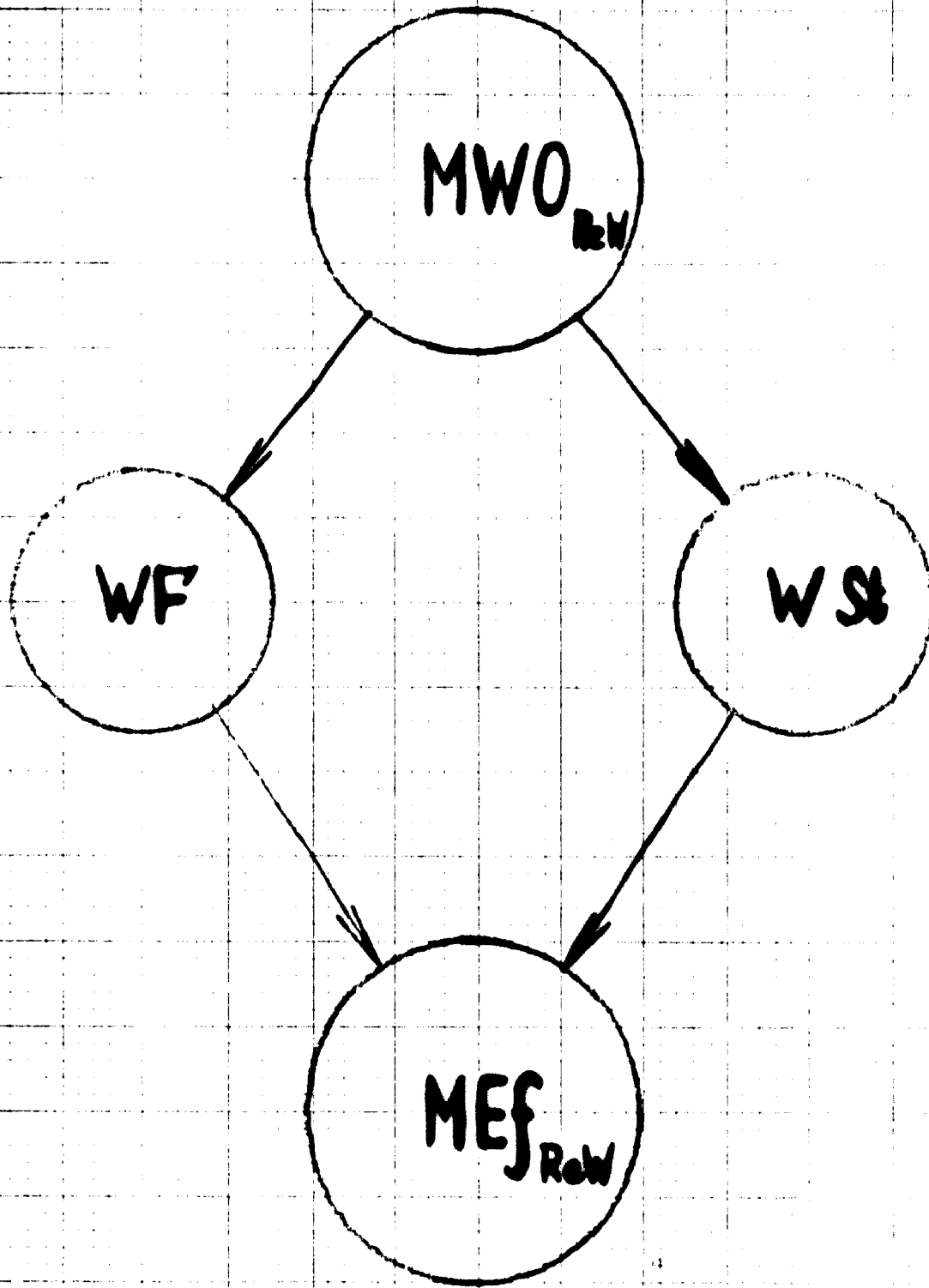


fig. 35: $MWO_{ReW} = \emptyset (WF; WSE)$ (KA)

model was represented on ~~fig.~~ fig. 36. In Research Work, from our aspects, the most important question is the problem of optimal creation (Cr_{opt}). This problem was represented on ~~fig.~~ fig. 37 and comprises of the following parameters: (Ne_{max}), (Cr_{max}) and (Ac_{opt}). On this scheme, the competences of the experts, concerning the question of estimation, were also represented.

4. Returning to the question, concerning previous proposal of the Research Work in meso-field of Building Units Production (BUP) which was represented on fig. 38, fig. 39 and fig. 40, indicates the basic scopes. On fig. 38, one example of trailers colony with trailers-units was given. On fig. 39 and fig. 40, one example of water cooling plants (recirculating system), with one kind of water cooling towers was given.

5. Discussing the problem of Research Work and Work Organisation, concerning the field of Building Industry, it is very important to underline one problem often evident in the Industrial Research Centres in the developing countries. By reason of consequence that the Industrial Research Centre is engaged simultaneously on the research work (ReW) and routine work (RoW), the misunderstanding among the researchers and the experts is often possible. Sometimes, the researchers look to the experts, engaged in routine work, as the minor important persons and the experts look, in opposite, to the researchers as the persons occupying with philosophic, abstract and non-concrete problems. This attitude is also the consequence of one very important fact: The researchers must always be free of everyday routine problems and correspondent actions, because they are engaged on the problems which can not be solved for one definite time. There are always better solutions, better than others and more and more better, which in the end open the possibilities for coming to the creation. In opposite, the experts (engineers and others) are always engaged on the problems, which must be solved in one foreseen - definite time. With the

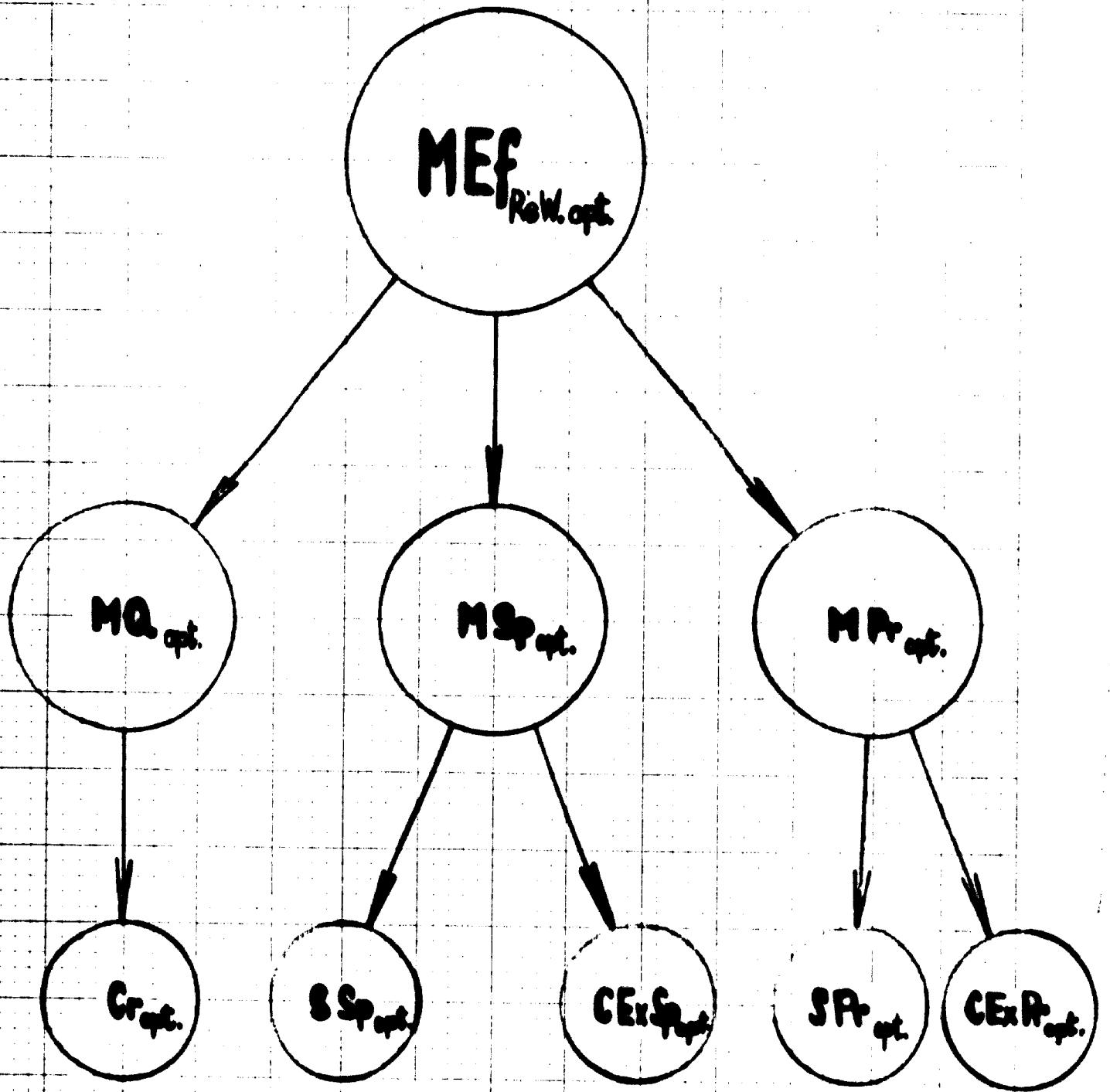
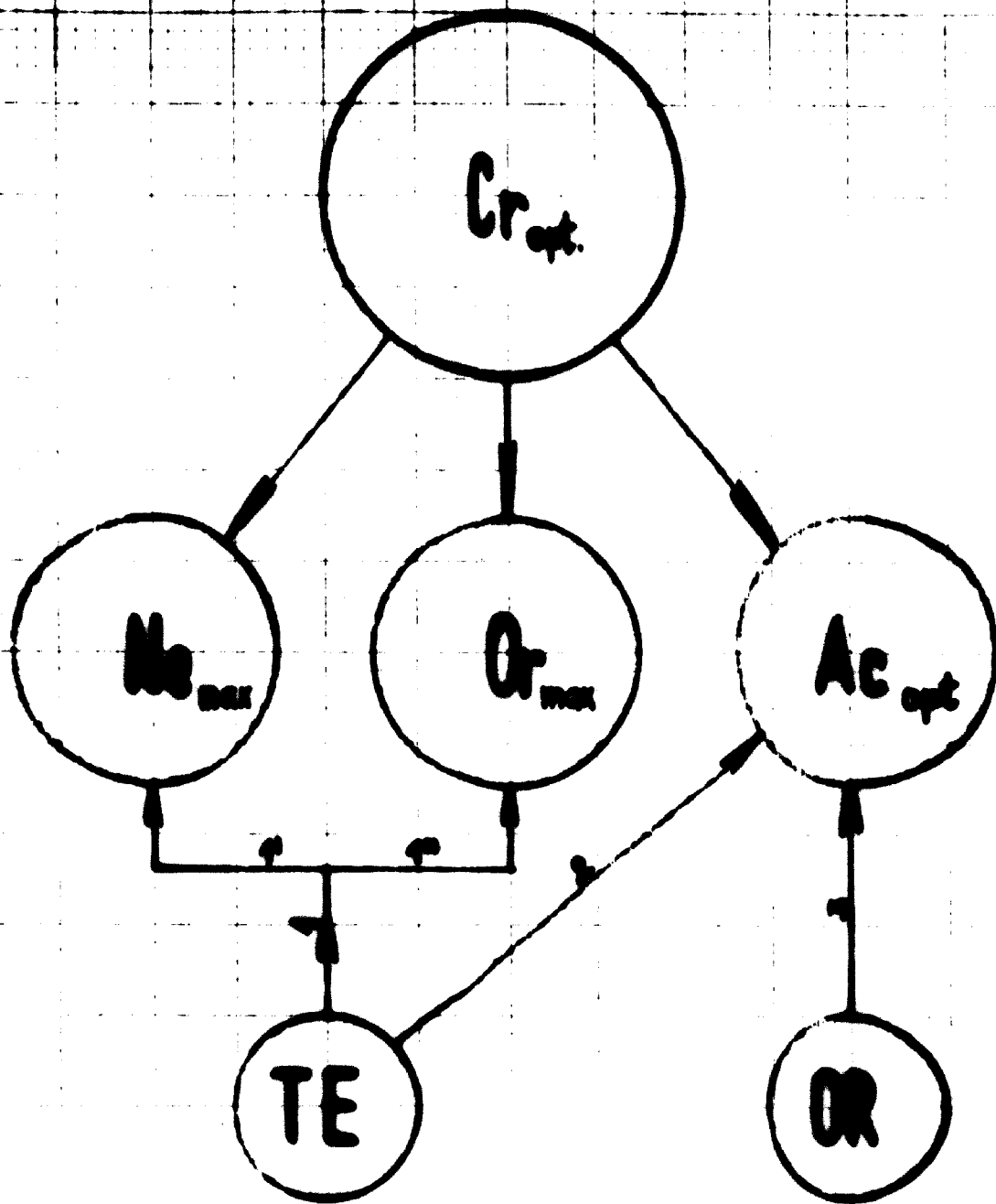


fig. 36: $MEF_{Rel.opt.} = \phi(Q_{opt.}; S_{opt.}; P_{opt.})$ (v.A)



NOTE:
1; 1'; 1''; 2; 3: CL

fig. 37: $Cr_{opt} = \emptyset (Ne_{max}; Or_{max}; Ac_{opt})$ — (KA)

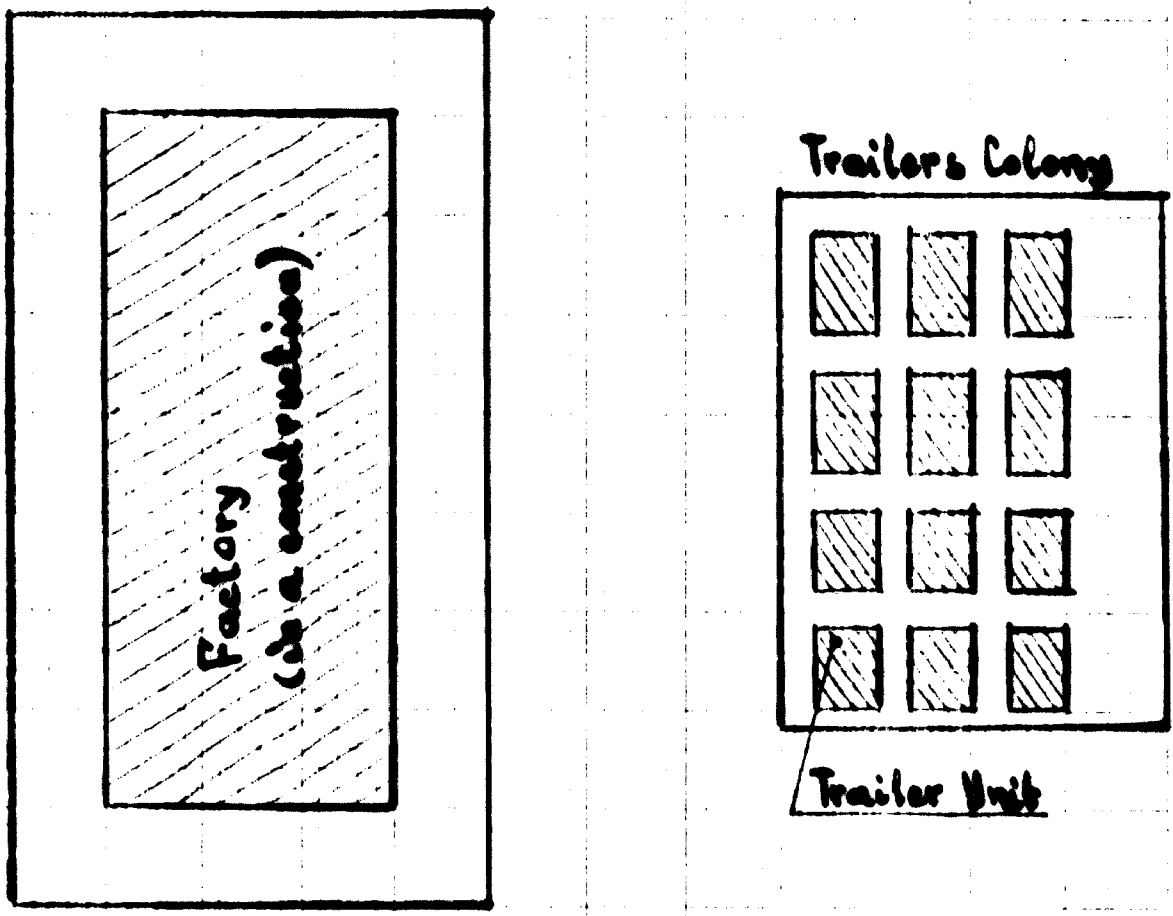
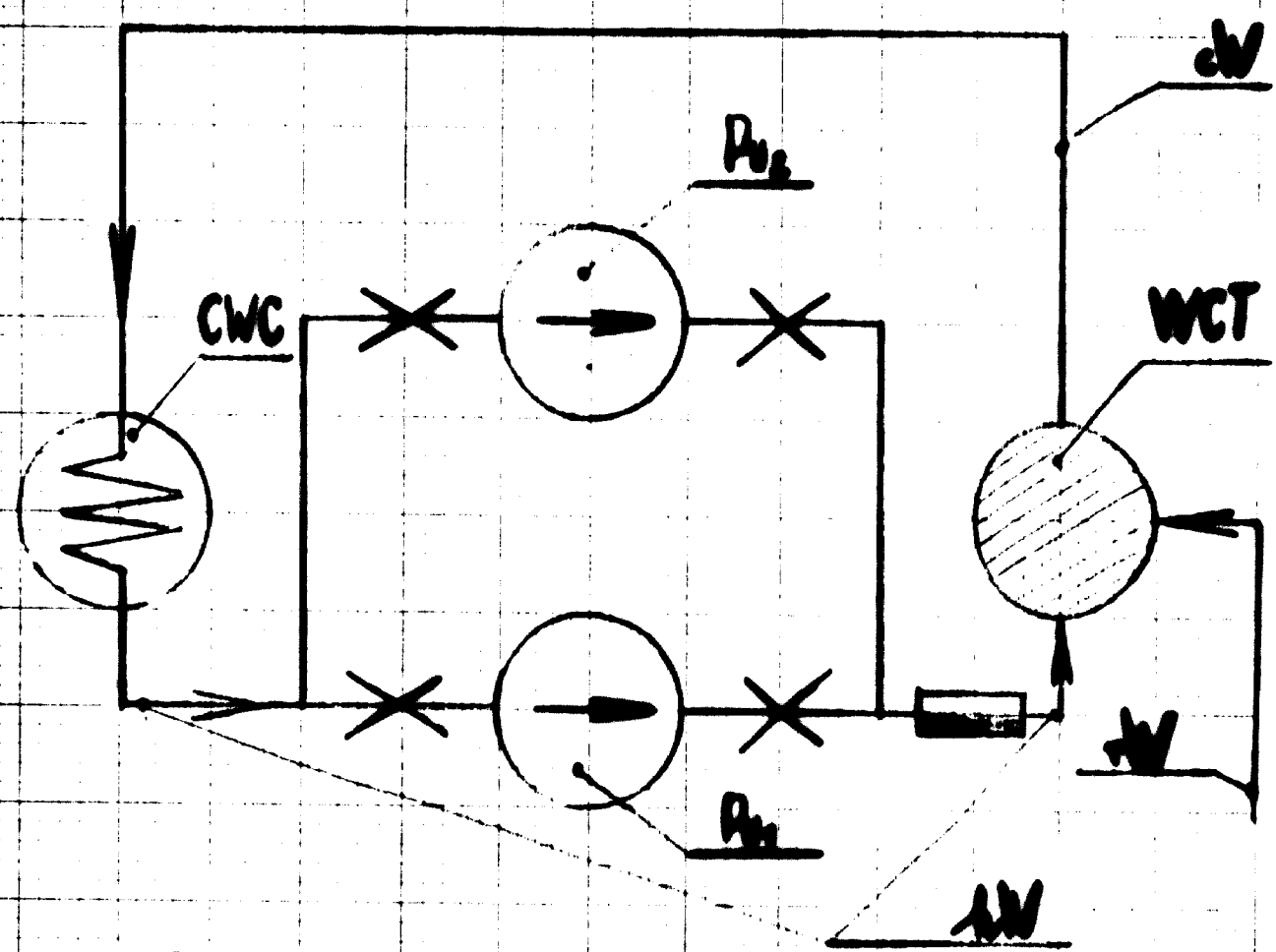


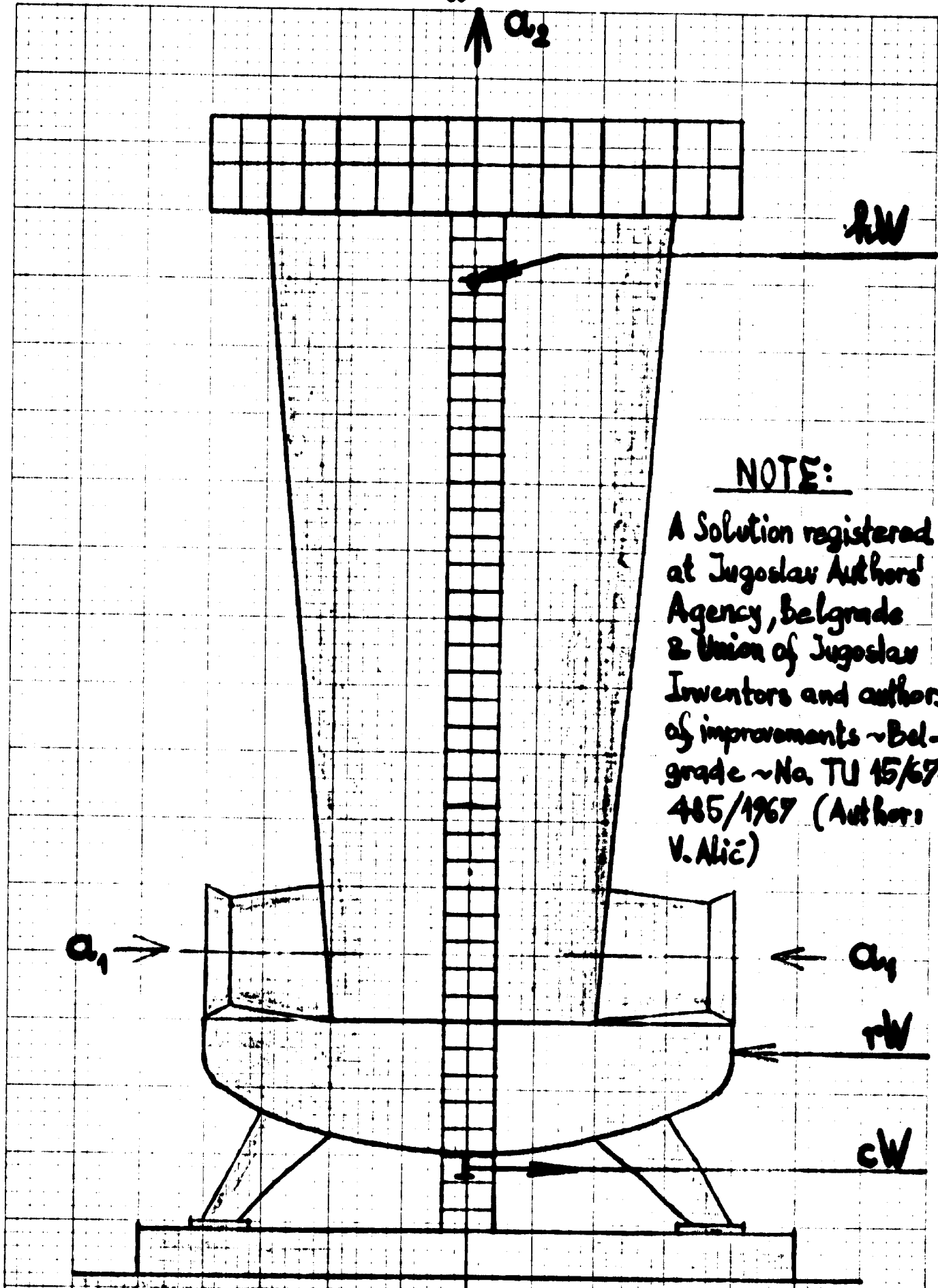
Fig. 38: Trailers Units and Colonies (KA)
/the example/



NOTE:
 $TW = (35-8\%)WW$

fig. 30: Scheme of a Water Cooling Plant
(a Recirculating System)

(VA)



NOTE:

A Solution registered at Yugoslav Authors' Agency, Belgrade & Union of Yugoslav Inventors and authors of improvements ~ Belgrade ~ No. TU 15/67 ~ 485/1967 (Authors: V. Alic)

Fig. 40: Water Cooling Tower

(VA)

full estimation to the problems of routine work (ROW), it is very necessary to evident this difference and at the same time the scope and volume of such work. The scheme of this work scope was represented on fig. 41.

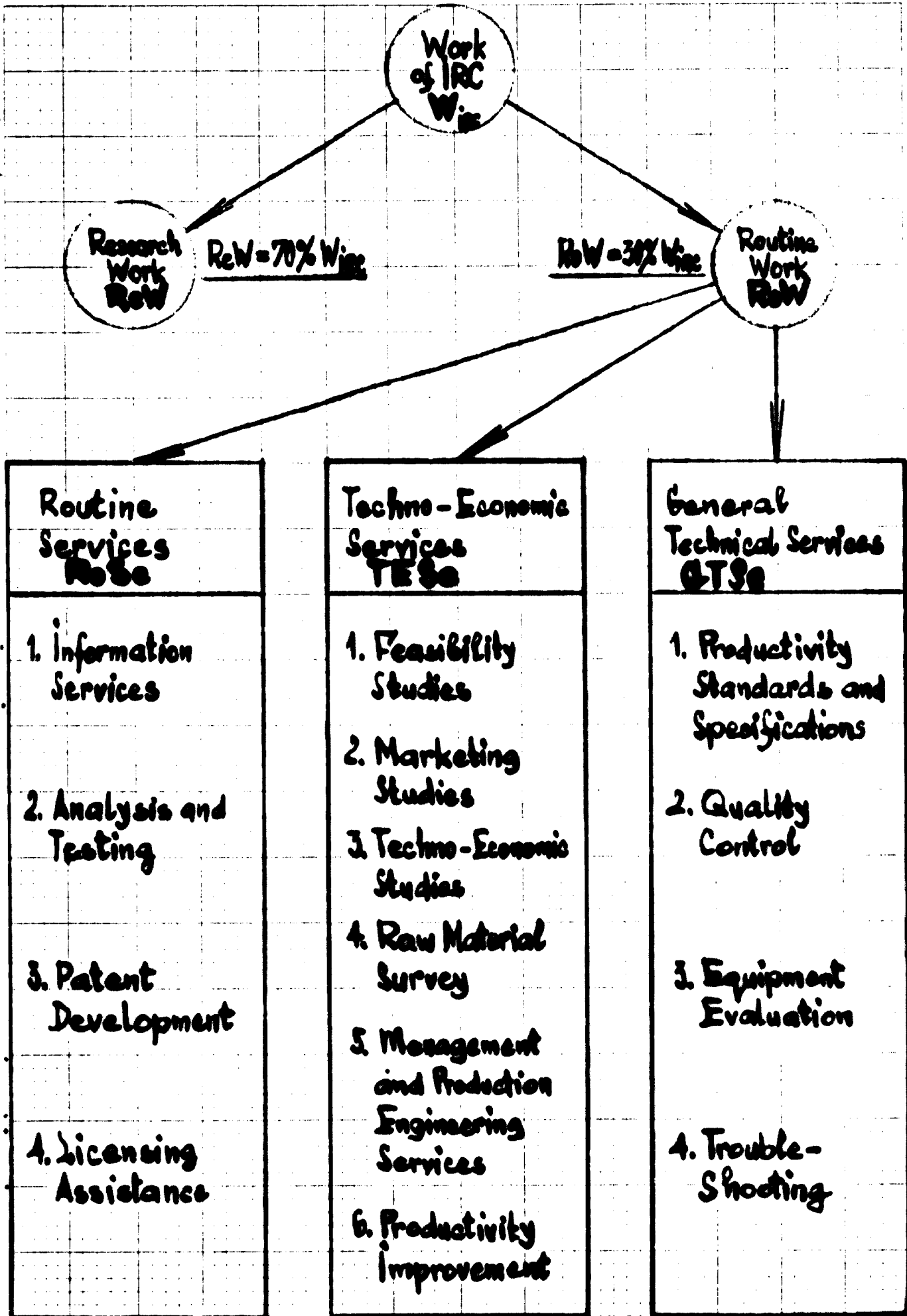


fig. 41: RoW = ∅ (RoSe; TESe; GTSe) (v.A)

VI CONCLUSION AND RECOMMENDATIONS

1. This Study, as it was previously said, represents one attempt of parabolic approach to the problems of Research Work (ReW) in the Industrial Research Centre (IRC), concerning the field of Building Industry (BI).
2. Many author's conceptions, considerations and theses concerning the problem of such Work, were represented in the correspondent parts of the Study.
3. Besides, the general and basic questions, the Study comprises also of the concrete proposals, referring the questions of the kinds and scopes of Research Work (ReW) and researchers (R).
4. The exposed proposals - which will be considered by competent Centre's heads and experts - would be completed and more detailed, after taken decision, concerning the selection of the kind and the scope of Research Work (ReW).
5. In the scope of decision, concerning the Research Work (ReW) in the field of Building Industry (BI), it is very important to pay the attention to the theses and conceptions, referring to the questions, such as followings: researchers' permanent education, model of Research Work and technology transfer. It is necessary to pay also the adequate attention to find the correspondent ways to obtain the possible results in this districts (permanent connection with university, internal courses, seminars, public lecturings and specialistic symposia etc.).
6. The very important manner of activities of Industrial Research Centre is also one closed connection and co-operation

with the correspondent local associations and organisations, occupying on the problems of Building Industry and the co-operation with the foreign similar centres.

7. It is necessary, that the ambitions of the Industrial Research Centre, in the scope of its affirmation in the Research Work in the field of Building Industry, would be characteristic by the attempts of one evident increasing of the correspondent researchers levels and numbers as followings: masters of sciences, (doctors of philosophy and doctors of science). These ambitions, don't represent one formal question, because the Research Work level will be, through the performings of adequate theses, undoubtedly increased.

8. It is very important also, that the ambitions of the Industrial Research Centre would be interwoven with the aspirations for the improvement of the knowledges of its experts, engaged in the Routine Work, connected with Research Work in Building Industry. This aspirations can be realized through the suitable trainings and specializations at correspondent foreign organizations.

9. The serious attention to the decisions, concerning the questions of the kinds, scope and volume of Research Work in the field of Building Industry (BI), is necessary, as the basis for considering the question of researchers.

10. The problem of researchers, foreseen for the Research Work in the field of Building Industry (BI), is undoubtedly the most serious and most difficult. The adequate proposal, concerning the solution of this problem, was given and it is necessary to pay correspondent attention to it.

11. The aspiration, concerning the participation on the correspondent national and international congresses and conferences referring to the scientific problems in the fields of Building

Industry (BI), with the original papers (as results of common researchers work) can be also as one spiritus movens in the scope of the complete ambitions of the Industrial Research Centre.

12. Being in the disposition for more detailed proposals concerning the fields of Research Work, chosen after the consideration of this Study by the component Centre's heads and experts - the author expresses his hope, that the expositions of correspondent problems, interpretations of adequate questions and the underlinings of the most important variants of its solutions, frame the necessary basic and clear picture, referring to the Research Work, comprised in the complete Work of the Industrial Research Centre, Tripoli, L.A.R., in the field of Building Industry for whose development there are many necessities, possibilities and perspectives.

VII LIST OF SYMBOLS

used on the schemes fig. 1 - 41

no.	symbol	definition	note
1	A	assistance	
2	Ao	acceptibility	
3	AReW	applied research work	
4	a ₁ a ₂	atmospheric air	
5	BD	designing for building industry	
6	BE	building engineering	
7	BEF	building elements production	
8	BI	Building Industry	
9	BMF	building materials prefabrication	
10	BRW	basic research work	
11	BSc	bachelor of science	
12	BUP	building units production	
13	CAD	documentation for construction and assembling	
14	CE	civil engineering	
15	CEPr	price of construction and exploitation	
16	CESp	speed of construction and exploitation	
17	Ch	chemical science	
18	CM	construction materials	
19	Cr	creation	
20	CRW	choice of research work	
21	cW	cooled water	
22	CWC	consumer of cooled water	

23	DC	developing country
24	DEs	designing e perience
25	DIRM	raw materials from different industries
26	DN	demographic necessity
27	DS	designing section
28	DSc	doctor of science
29	E	engineering
30	EE	engineer engaged in the field of engineering
31	ES	engineering section
32	F	foreign
33	FA	financial assistance
34	FC	foreign conditions
35	FDO	foreign design organization
36	FEO	foreign engineering organisation
37	FO	foreign organisation
38	FRow	fundamental research work
39	G	government
40	GTSc	general technical services
41	HDC	high developed country
42	HW	heated water
43	I	improvement
44	ID	individual designers
45	IIE	individual engineers engaged in the field of engineering
46	IIs	industrial experience

47	In	innovation	
48	IN	industrial necessity	
49	IOG	iso-operation curve	term proposed by Dr. V. Alic
50	IOP	iso-operation point	- " -
51	IPC	iso-process curve	- " -
52	IPP	iso-process point	- " -
53	IRC	Industrial Research Centre	
54	IRM	imported raw materials	
55	IvC	investment conditions	
56	IKH	know-how	
57	L	local	
58	LC	local conditions	
59	LDO	local designing organisation	
60	LEO	local engineering organization	
61	LP	laboratory plant	
62	LFD	laboratory plants design	
63	LPF	local plants factory	
64	LRw	Research Work level	
65	LRM	local raw materials	
66	N	mathematic science	
67	max	maximum	
68	MC	methods of calculations	
69	MPP	model of problem definition	
70	ME	mechanical engineering	
71	MER _{Res}	model of efficiency in research work	

72	MEx	model of experience
73	MLe	model of level
74	MM	mathematical modelling
75	MP	model of programme
76	MPA	model of parabolic approach
77	MPr	model of price
78	MQ	model of quality
79	MR	model of researchers
80	MReW	model of Research work
81	MS	model of solutions
82	MSc	master of science
83	MSp	model of speed
84	MTA	model of tangential approach
85	MWO _{Rew}	model of work organisation in Research Work
86	N	necessity
87	Ne	new
88	NRM	natural raw materials
89	Opt	optimal
90	Or	originality
91	OR	operational research
92	P	plant
93	PA	plants assembling
94	PC	plants construction
95	PD	plants design
96	PE	export possibilities
97	PhD	philosophy doctor

98	PP	pilot plant
99	PPD	pilot plants design
100	PR	plants researchers
101	PS	plants section
102	Pu	pump
103	R	researchers
104	RoW	Research Work
105	RoW (B1)	Research work in the field of Building Industry
106	REs	research experience
107	RM	raw materials
108	RMS	raw materials sources
109	RoSo	routine services
110	RoW	routine work
111	RPE	researchers' permanent education
112	R_t	total number of researchers
113	rw	recompensing water
114	SE	survey of existing
115	SPr	price of solution
116	SSp	speed of solution
117	T	type
118	TA	technical assistance
119	TE	technical experts
120	TED	techno-economic department
121	TES	techno-economic services
122	TOC	technical and organisational conditions

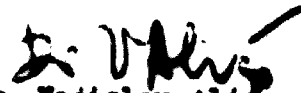
123	TP	technological process	
124	TPR	technological processes researchers	
125	TPS	technological processes section	
126	TPaP	complete plants for separate technological process	
127	TT	technology transfer	
128	U	university	
129	UOE	unit operation engineer	
130	UOP	unit operation point	term proposed by Dr. V. Alie
131	UPE	unit process engineer	
132	UPP	unit process point	term proposed by Dr. V. Alie
133	VRw	Research work volume	
134	WOT	water cooling tower	
135	WF	work fortification	
136	WIRC	complete Work of Industrial Research Centre	
137	WO	work organisation	
138	WOS	work organisation section	
139	WST	work strategy	
140	Tw	time of work	

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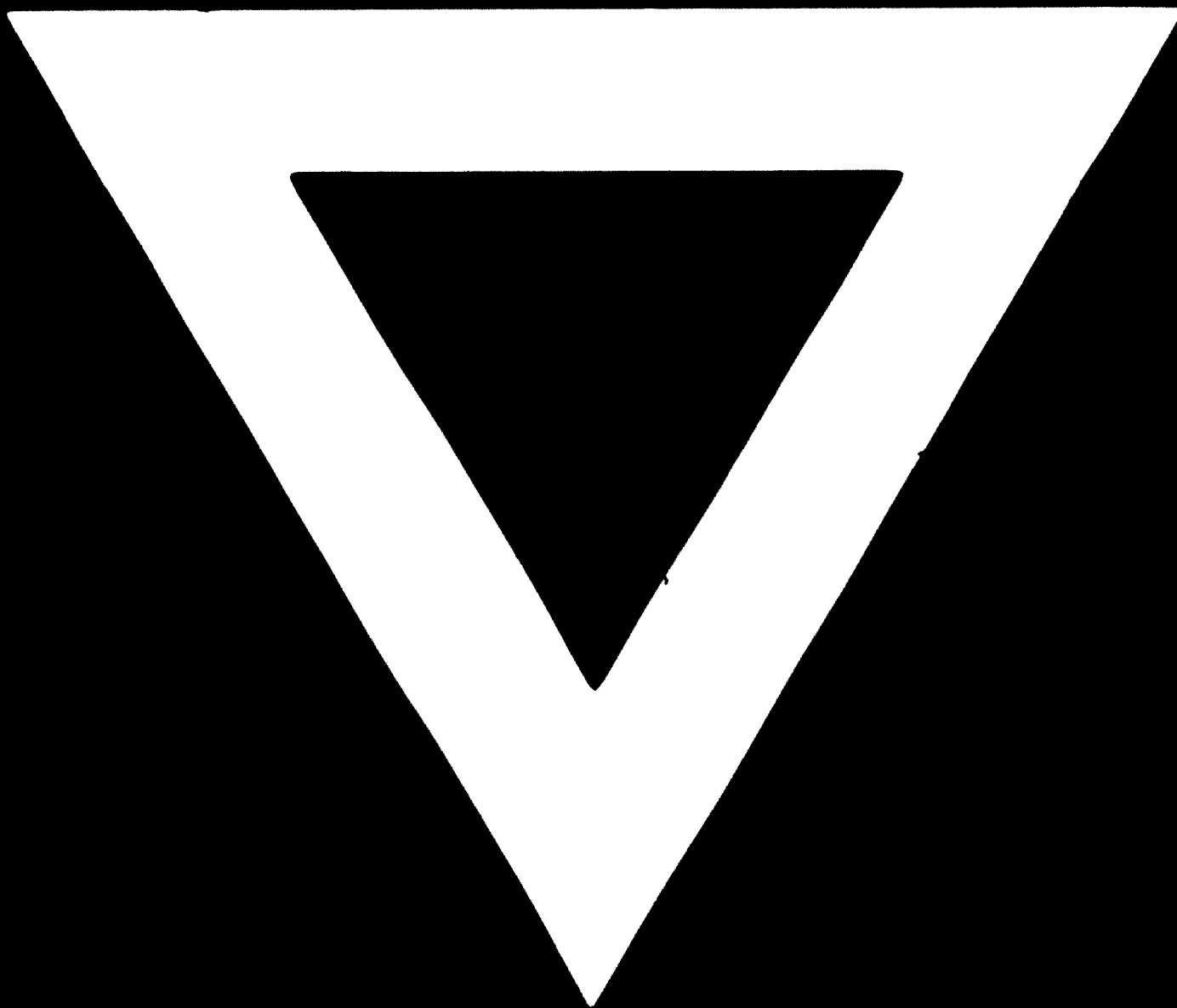
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G-582



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