AID/NASA PILOT PROJECT FOR TECHNOLOGY TRANSFER TO A DEVELOPING NATION

— REPUBLIC OF KOREA —

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KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY

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FINAL REPORT

ON

AID/NASA PILOT PROJECT FOR TECHNOLOGY TRANSFER TO A DEVELOPING NATION

- REPUBLIC OF KOREA -

TO

THE OFFICE OF SCIENCE AND TECHNOLOGY

BUREAU FOR TECHNICAL ASSISTANCE

AID, U. S. DEPARTMENT OF STATE

June, 1972

BY

TEAM OF KIST PARTICIPANTS

KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY

PREFACE

The transfer of technology, in particular from an advanced nation to a developing nation, is an essential means for the development of industry and is most effective when it is absorbed in such a way as to provide a springboard for the move into the next stage of industrialization. In a developing nation, technology transfer and its absorption are vital to foster a rapid, but orderly, economic growth of the country.

The program described in this report is a pilot study conducted to determine the feasibility of and to establish a refined methodology for the transfer of aerospace-developed technology to developing nations. The project was funded by the Agency for International Development (AID) through the National Aeronautics and Space Administration (NASA).

The goals set for evolving a transfer methodology applicable to Korea using Korea Institute of Science and Technology as an active intermediary and actual transferring of aerospace-developed technology in areas of potential economic advantage were successfully attained.

I wish that the model developed through this pilot project and presented in this report may set a precedent on technology transfer to developing nations. My special gratitude is due to the Agency for International Development of the United States and the Government of the Republic of Korea for their positive support to this project. I also wish to acknowledge the generous cooperation rendered by both NASA and the IIT Research Institute.

July, 1972

Sang Joon Hahn
President
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* AID for funding the pilot project;

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* U.S. governmental agencies and industrial firms for their cooperation and assistance during information gathering visits;

* ROK government, Korean industries and KIST for funding the international travels of the Korean participants and the applications engineering necessary for successful technology transfers; and

* Dr. R. Douglas Johnson, a Peace Corps Volunteer serving at KIST, for his unique assistance and untiring efforts in the preparation of this report.

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SUMMARY

The Korea Institute of Science and Technology (KIST) presents this report as an evaluation of an international technology transfer program from the viewpoint of a recipient nation.

The program was a pilot study to determine the feasibility of and to establish refined techniques for the transfer of aerospace-developed technology to developing nations. The Illinois Institute of Technology Research Institute (IITRI) and its subcontractor, the Aerospace Research Applications Center (ARAC) of the University of Indiana, under contract to the National Aeronautics and Space Administration (NASA), executed this twenty-four month program with the Republic of Korea (ROK) as the recipient nation. The Agency for International Development (AID) provided funds to NASA in support of this project.

The dual active intermediary approach to technology transfer was implemented. This approach requires the participation of two organizations with wide contacts in local technology, one in the donor nation and the other in the recipient nation. IITRI assumed the role of the donor-nation intermediary, which acts as a "clearing-house" for technological information acquired for the recipient-nation intermediary. KIST was selected as the intermediary for the recipient nation, which acts as a "gate-keeper" for importation of foreign technology.

The goals of the program included the following:

* training of KIST personnel in the methodology of technology transfer and the utilization of technology resources,

* evolving and implementing modified transfer techniques applicable to Korean industry using KIST as an active intermediary, and

* actual transferring of aerospace-developed technology in areas of potential economic advantage.

Each of these goals was successfully attained.

The evaluation of the results indicated that the effectiveness of future technology transfer program could be improved by better selection of the problems proposed for solution and by the use of a more comprehensive collection of technical data for identification of possible solutions.

The selection of technical problems could be improved by requiring a preliminary techno-economic feasibility study of each problem to determine that existence of an appropriate solution would result in immediate implementation with a salutary effect on the recipient-nation economy.

As aerospace-developed technologies often represent incremental developments of the advanced U.S. technological bases, and as the corresponding technologies in the recipient nation are usually not so well developed, such incremental technologies cannot be utilized unless accompanied by substantial amounts of the basic technologies. Thus, access to resources encompassing a wider range of technical information would permit identification of solutions to a greater variety of problems and would result in transfer of a mixture of incremental, partial, and total technologies to the recipient nation.

It is also emphasized that direct contacts between the recipient-nation intermediary and the donor-nation technology sources are very important to the achievement of successful tranfers.

I. INTRODUCTION

Technological advancement and industrial expansion are vital factors in the socio-economic growth of any nation. In a developing nation, contact with foreign technology is especially important because the nation depends on the emergence and introduction of new industries and improved technologies to foster a rapid, but orderly, economic growth. Emerging countries have traditionally relied on the importation of complete industries from foreign sources to meet this need. However, one characteristic of a developing nation is that not all of its industries have achieved the same degree of advancement. Some remain unmodernized and traditional, while others are self-developing and capable of readily assimilating the most sophisticated recent technological advances. Most of its industries lie between these extremes. As a result, continued development of the entire industrial base requires the transfer of foreign technologies at all levels of sophistication.

The program described in this report was a pilot study designed to determine the feasibility of and to establish refined techniques for the transfer of aerospace-developed technology to developing nations. The Illinois Institute of Technology Research Institute (IITRI) and its subcontractor, the Aerospace Research Applications Center (ARAC) of the University of Indiana, under contract to the National Aeronautics and Space Administration (NASA), conducted this twenty-four month program with the Republic of Korea (ROK) as the recipient nation. The Agency for International Development (AID) provided funds to NASA in support of the program.

The goals of the program were:

(1) Train Korean personnel in the techniques of technology transfer and the utilization of technology resources.

(2) Evolve and implement modified transfer techniques applicable to Korea.

(3) Achieve specific transfers of aerospace-developed technology in areas of potential economic advantage.

(4) Develop a revised training and implementation plan based on success and failures.

(5) Evaluate the techniques in terms of applicability to developing nations in general.

The methodology utilized by this program was the dual active intermediary approach to international technology transfer. This approach requires the participation of two organizations, one in the donor nation and one in the recipient nation, which have wide contacts with local technology and are experienced in the techniques of technology transfer.

The Korea Institute of Science and Technology (KIST) was selected as the recipient-nation intermediary because it occupies a unique position in the government/industry/university complex of Korea. It is a young organization established with government support to interact directly with Korean industry and to provide the technical research and development necessary for technological advancement and diversification. Over the past few years, KIST has been recruiting skilled, highly competent scientists and engineers -- many with foreign training and experience -- to develop its staff. At the same time, KIST has established itself as a valuable technological resource in Korea through development of wide industry relations through successful performance of projects for both government and industries involving important problems of immediate concern and by development of a broad technological base of experience in many scientific disciplines.

KIST provided the Korean participants for the training phase of the program and served as the "gate-keeper" for the importation of foreign technologies. Its role was to define problems of importance to Korean industry and to the Korean economy, to perform any necessary applications engineering when a potential solution of economic interest had been identified, and to interact with Korean industry to assist in the adoption and implementation of the technology. Thus, KIST would channel appropriate technologies, specifically adapted to Korean needs, into the Korean industry.

In addition to providing overall supervision for the project and training the Korean personnel in the methods of technology transfer, IITRI assumed the role of the donor-nation intermediary during the actual transfer phase of the program. In this "clearing-house" capacity, it coodinated the search for information relevant to the problems submitted by KIST, assisted in the identification of potential solutions, and organized the follow-up trips on which Korean experts obtained first-hand knowledge of the selected technologies.

This report presents an evaluation of the pilot project from the viewpoint of the Korean participants. Therefore, it emphasizes those phases in which they were directly involved: training and technology transfer. The major achievements of the program within these areas may be summarized as:

(1) 5 members of KIST staff received training in the methods of technology transfer and the utilization of technology resources.

(2) 51 technical problems in 5 areas of economic importance to Korea were defined.

(3) Relevant aerospace-developed technologies were found for 16 problems.

(4) 4 technologies -- in electronics and component manufacture -- were transferred to Korea and prepared for utilization by Korean industries.

(5) Awareness of KIST by the ROK government and Korean industries as an active intermediary in technology transfer and as an agent of technological advancement has been enhanced.

II. PROGRAM ACTIVITIES

This program, a pilot study for the transfer of technology to a developing nation, has been carried out over a period of approximately two years with the Republic of Korea as the recipient nation. The dual active intermediary approach to international technology transfer was implemented. The role of donor-nation intermediary was assumed by IITRI, while KIST was selected to be the recipient-nation intermediary.

The program had as its goals:

(1) Train Korean personnel in transfer methods and technology resource utilization.

(2) Evolve and implement modified transfer techniques applicable to Korea using KIST as an active intermediary.

(3) Achieve specific transfers of aerospace-developed technology in areas of potential economic advantage.

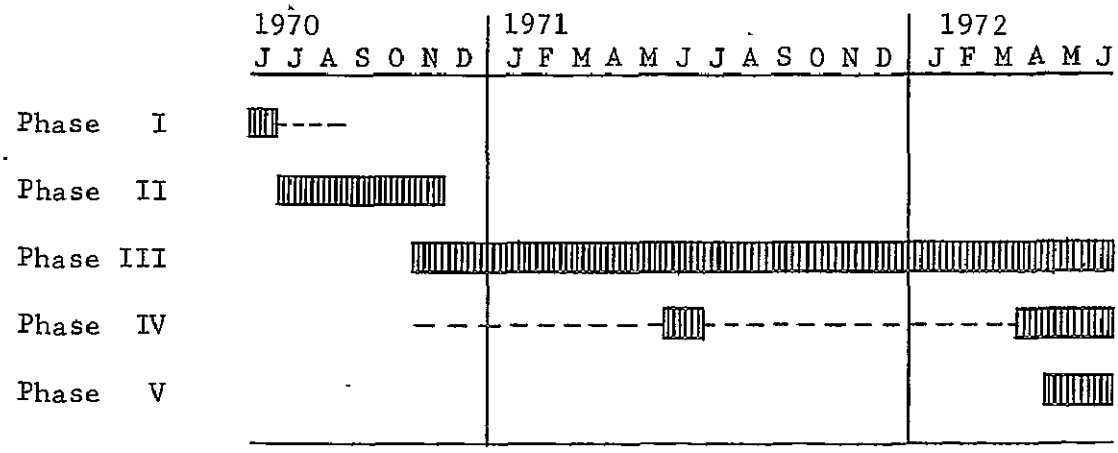
(4) Develop a revised training and implementation plan based on successes and failures.

(5) Evaluate the techniques in terms of applicability to developing nations in general.

In order to achieve these goals, a program consisting of five discrete phases was designed. The following table identifies the purpose of each phase.

Phase I	-	Technical mission to Korea and program scheduling
Phase II	-	Training of Korean specialists, organization of total project and communications, and problem processing
Phase III	-	Identification, follow-up, and transfer of technologies
Phase IV	-	Evaluation and report
Phase V	-	Development of plan for possible institutionalized continuation

The scheduling of these phases within the overall program is shown in the figure below.



The following sections discuss the activities during each phase from the viewpoint of the Korean participants. More detailed descriptions of each phase may be found in the periodic IITRI reports on Project V6110.

Phase I Activities

Phase I of the program commenced on June 8, 1970, with the arrival in Seoul, Korea, of a team of U.S. technology transfer experts. The team stayed in Korea for two weeks. The membership of the team and its itinerary are given in Appendix A. The objectives of Phase I were:

(1) Obtain information on Korean technology, industry, labor, government and economy to assist in choice of technology areas, establishment of evaluation criteria, personnel selection, etc.

(2) Obtain information on communication channels and institutional relationships to help establish initial emphasis on best transfer techniques.

(3) Inform Korean personnel about the program and its potential.

(4) Initiate steps to develop trial problems for use in Phase II.

(5) Assist in establishing guidelines for selecting Korean personnel to implement Phases II and III.

(6) Utilize information obtained to finalize program plans for Phases II-V.

The technical mission to Korea was reasonably successful and reached the established objectives. They found that the Republic of Korea has most of the elements necessary for a successful program of technology transfer.

Today's Korean industry, with few exceptions, is highly labor intensive and in many cases is based on foreign technology, components, and process machinery. Clearly, this was a quick way in which to progress from an agricultural economy to the present state of semi-industrialization. However, the mission found that the concept of investment in research and development to acquire new products and processes is a new idea to industries in Korea.

The assessment of the U.S. team during the visit was that nearly every industrial company toured showed a need for or interest in incremental technology to improve their operations and could utilize new technology to expand their production to new products. However, the prevailing attitude, they noted, was one of conservatism and general reluctance to make changes or invest resources where any sizeable amount of risk or capital was involved.

The Phase I visit included a detailed briefing on the program goals and methodology, and a description of the NASA Aerospace Data Bank. The U.S. team stressed at that time that transfers of technology might take longer to achieve than the contract time period. Thus, in order to implement several transfers during the program period, the KIST staff would have to devote extensive effort to the mechanics of transfer and to applications engineering. KIST agreed to do whatever was necessary to bring about transfers within the program time frame.

Phase II Activities

The specific objectives established for Phase II were:

(1) Select members of KIST technology transfer team.

(2) Formulate initial list of technical problems confronting Korean industries to be solved by technology transfer.

(3) Train KIST team members in methods of technology transfer.

(4) Process initial list of technical problems.

(5) Establish personal acquaintance with appropriate NASA and contractor personnel.

(6) Evolve transfer mechanisms and implementation plan for conduct of Phase III.

(7) Establish effective communication between ROK and U.S. program elements, taking specific note of geographic barriers.

The methods of technology transfer applied in Phase II and Phase III were based on those developed and used by NASA's Biomedical and Technology Application Teams. A problem-definition/problem-solution approach was implemented. This approach consists of four specific steps:

Step 1 - Problem Selection and Definition

A problem is selected utilizing such criteria as economic impact and significance, urgency, availability of sponsor to carry on adaptive engineering work, implementation potential, and possibility of finding a usable solution. Then it is defined very specifically in scientific and technical terms and written up in a brief problem statement.

Step 2 - Literature Search and Information Gathering

Based on the problem statement, literature search strategies are prepared. Implementation of these strategies locates information which might provide a solution to the problem.

Step 3 - Information Analysis and Evaluation

All the information obtained from the literature search is reviewed and evaluated by a staff scientist or engineer with background in the problem area and all potential solutions are identified. When this is completed, the source of each potential solution (such as government agency or contractor) is contacted personally so that an in-depth review can be made of the technical aspects of the proposed solution.

Step 4 - Technology Transfer

When an appropriate solution has been found and the solution has been agreed upon by all parties involved, a "transfer strategy" is established. This is essentially a listing of various tasks associated with bringing about a complete technology transfer, i.e., actual implementation of the proposed solution to eliminate the existing problem.

The second phase of the program began with the selection of a five-man team from KIST who would visit the U.S. to obtain training in the

methods of technology transfer. The criteria applied in choosing the team members included:

* technical expertise, especially in areas closely related to those industries with need and reasonable probability of acceptance of transfer;

* bilingual communicative ability;

* aggressiveness, high personal interest in the program, previous industrial experience, and high degree of contact with Korean industry;

* optimum organizational positioning in Korean university/industrial/government complex;

* available time to pursue the program; and

* an appreciation of development costs, market and other economic factors related to the impact of innovation.

The particulars for each member of the team are given in Appendix B. The following technical areas were represented:

* Chemistry and Chemical Engineering (CE)

* Electrical and Electronics Engineering (EE)

* Food Technology (FT)

* Mechanical Engineering (ME)

* Metallurgy and Materials Technology (MM).

A total of 51 problems were proposed by the KIST team for solution by technology transfer. Table I is a listing of the titles of these problems, while Appendix E contains the complete problem statements grouped by technical area. Solutions appropriate to these problems ranged from incremental developments of Korean industries to importation of total technologies. Some of the problems had obvious need of solution, while others were intended as "shots in the dark" or for information gathering.

TABLE I. Listing of Problems Initially Proposed

CE-1	Elimination of carbon monoxide in anthracite coal burning
CE-2	Lightweight thermal insulation
CE-3	Improved pressure-sensitive adhesives
CE-4	Clear polyvinyl-chloride bottles
CE-5	Modacrylic fiber technology
CE-6	Antioxidant for nylon
CE-7	Adsorbents for gas masks
CE-8	High-alkali detergents
CE-9	Hydrogen peroxide
CE-10	Freon
CE-11	Fiber-reinforced plastics
CE-12	Ball explosive process
CE-13	Reflective paints
CE-14	Flame retardants and antistatic additives
EE-1	Miniature transceivers for personal radios
EE-2	Lead-calcium alloy manufacturing technology for electric battery plates
EE-3	High-sensitivity transceivers
EE-4	An indicating instrument to specify the charge state of secondary batteries
EE-5	Manufacturing of solar cells for a power source
EE-6	Non-destructive testing by microwave
EE-7	Solid-state display device for desk calculators and digital instruments

EE-8	Manufacturing technology of Al-foil conductor
EE-9	Laddic technique
EE-10	Manufacturing technology of fractional horsepower mini-motor
EE-11	A method for determining the usable energy of primary batteries
EE-12	Technology for elimination of static electricity due to friction
EE-13	High-voltage/high-current pulse generator
EE-14	Small electrical power sources for remote offshore isles
EE-15	Low-cost electrical utility poles
EE-16	Construction of Automatic Picture Transmission ground equipment for weather satellite picture receiving stations
EE-17	Infrared image converter
EE-18	Inductorless communication circuits
FT-1	An economical retort pouch for use as a "flexible can"
FT-2	Filtration methods for removing bacteria from air
FT-3	Bacteriophage monitoring in fermentation industries
FT-4	Continuous maintenance of reduced oxygen and carbon dioxide contents in atmosphere of warehouse for apples
FT-5	All-purpose survival rations
FT-6	Low-cost process for harvesting and drying micro-algae
FT-7	Food additive togenerate heat with water for instant rice
ME-1	Injection nozzle used for diesel engine
ME-2	Magnetic ink and sensor
ME-3	Die-casting technology for non-ferrous materials
ME-4	Computer programs for management
ME-5	Sensor technology

MM-1	Processing of tungsten ore concentrates (scheelite) to tungsten powder
MM-2	Inorganic coating of steel for fabrication of chemical reaction vessels
MM-3	Production technology of graphite electrodes from natural graphite
MM-4	Tantalum solid electrolytic capacitor
MM-5	Ferric oxide preparation as magnetic ferrite powder
MM-6	Sintered aluminum powder products
MM-7	Explosive metalworking of mild steel

The training portion of this phase began with the arrival of the Korean team at IITRI on August 24, 1980 and ended with their departure on October 15, 1970. During this period of 37 regular working days, the members of the team received training in technology transfer methods. A working knowledge of the technical resources available under the program was developed by actually processing trial problems through the various stages of complete problem definition, literature search, information evaluation, and initial technology follow-up. A schedule of the Phase II activities in the U.S. is included in Appendix B.

All of the problems were submitted to the Aerospace Research Applications Center (ARAC) for processing. Complete keyword search strategies were prepared by the KIST team for 20 problems, while ARAC personnel prepared the others. The literature searches implementing these strategies utilized various combinations of the following information sources:

* Scientific and Technical Aerospace Reports
* International Aerospace Abstracts
* Defense Documentation Center File
* Engineering Index
* Institute of Textile Technology File
* United States Government Research and Development Reports
* Nuclear Science Abstracts.

These last four sources were included because many of the problems required technology of a more general nature than that developed by the aerospace industry.

A good indication of the relevance of the information located by the literature searches is the number of documents ordered by the KIST Team. During the team's visit, a total of 60 searches were performed, 38 of these were evaluated by the team, and approximately 980 documents were ordered -- an average of nearly 26 documents per evaluated search.

In addition to providing some specific potential solutions, the literature searches were also a good source of leads for locating the industries and agencies involved in various areas of research. Further, they were found to be extremely detailed sources of technical background information in the fields covered by the problems.

On the basis of the information located by the literature searches, the KIST team members made 26 personal industrial contacts to obtain additional data pertinent to the problems in their fields. These Phase II trips are also tabulated in Appendix B.

Additional literature searches were completed after the team's return to Korea. Final evaluation of the search results indicated that significant amounts of technical information had been located for 16 of the 51 problems. These problems are listed in Table II.

TABLE II. Listing of Problems with Significant Amounts of Relevant Technology

CE-1	Elimination of carbon monoxide in anthracite coal burning
CE-2	Lightweight thermal insulation
CE-8	High-alkali detergents
CE-12	Ball explosive process
EE-1	Miniature transceivers for personal radios
EE-3	High-sensitivity transceivers
EE-4	An indicating instrument to specify the charge stage of secondary batteries
EE-6	Non-destructive testing by microwave

EE-16 Construction of Automatic Picture Transmission ground equipment for weather satellite picture receiving stations

EE-18 Inductorless communication circuits

FT-1 An economical retort pouch for use as a "flexible can"

FT-5 All-purpose survival rations

ME-2 Magnetic ink and sensor

ME-5 Sensor technology

MM-4 Tantalum solid electrolytic capacitor

MM-7 Explosive metalworking of mild steel

Phase III Activities

Phase III, which was designated for technology evaluation and transfer, began after the departure of the KIST team for Korea in mid-October, 1970. After comprehensive technology evaluation, KIST decided to restrict its active transfer efforts to those problems dealing with electronics technology. This decision was made for the following reasons:

(1) Technologies, both aerospace and commercial, applicable to problems in the field of electronics had been identified during the Phase II activities.

(2) The Korean electronics industry is reasonably advanced and could probably assimilate these technologies without much difficulty.

(3) Concentration of resources on a single industry would increase the probability of a successful technology transfer which could then be used to demonstrate the concept to other industries.

This decision and the supporting analyses led to the selection of four problems for intensive follow-up in the U.S. by KIST personnel. An additional five problems were selected for longer range follow-up and possible transfer. The sets of problems are given in Tables III and IV, respectively.

TABLE III. Problems Selected for Intensive Follow-up and Immediate Transfer

EE-1	Miniature transceivers for personal radios
EE-3	High-sensitivity transceivers
EE-18	Inductorless communication circuits
MM-4	Solid tantalum electrolytic capacitors

TABLE IV. Problems Selected for Limited Follow-up and Monitoring

CE-1	Elimination of carbon monoxide in anthracite coal burning
EE-16	Construction of Automatic Picture Transmission ground equipment for weather satellite picture receiving stations
FT-1	An economical retort pouch for use as a "flexible can"
FT-5	All-purpose survival rations
MM-7	Explosive metalworking of mild steel

During the first half of 1971, four KIST researchers spent a total of four man-months in the U.S. working with IITRI personnel on the intensive follow-up problems. The personnel involved and their schedules are included as Appendix C. A total of 44 organizations were contacted. Each of the Koreans felt his trip was productive and successful in that he had obtained the information necessary to begin implementation and initiate applications engineering activities.

By the end of the program contract period in June, 1972, applications engineering for the four projects selected for intensive follow-up had been completed. In one case (EE-1), a firm commitment for commercial production had been obtained from a Korean manufacturer. Further, funding had been received from the ROK Central Meteorology Office to establish a

ground station to receive weather satellite picture transmission. Thus, effectively, one of the five "limited follow-up" problems (EE-16) has been promoted into the "intensive follow-up" group. Applications engineering on this project is expected to be completed by December 1972.

Reports on the transfer activities undertaken for the four "intensive follow-up" projects are presented in Appendix G. The current status of each of the five projects selected for limited follow-up and monitoring is described in Appendix H.

Phase IV Activities

The main purpose of Phase IV was program evaluation. Two major evaluation meetings were held during the course of the program.

An interim evaluation meeting was held in June, 1971, involving representatives of all participating organizations. Dr. Hyung Sup Choi, then KIST President and currently ROK Minister of Science and Technology, emphasized the fragmented infrastructure of developing nations and the corresponding need to introduce major commercial manufacturing capabilities. As a result of the uneven development of Korean industries, it was likely that transfers resulting from this program would be a mixture of aerospace and commercial U.S. technology. He further stated that the affiliation of KIST with AID and NASA would assist KIST in promoting the concept of research and development to the generally conservative Korean industrial scene.

Some concern was also expressed at this meeting about the time scale of the transfer project. Previous experience in Korea had shown that the time required to progress from laboratory prototype to commercial product is longer than in a developed nation. Therefore, it was recommended and agreed that the transfer program contract should be extended from its original termination in December, 1971 until June, 1972. This would permit completion of applications engineering programs at KIST and would allow a more comprehensive evaluation of the program in Korea during the spring of 1972.

A program evaluation team visited Korea for eleven days beginning April 17, 1972. The members of this team and their schedule of activities are described in Appendix D. The progress of applications engineering for each of the four projects selected for immediate transfer was reviewed, as were the status of the five problems selected for delayed transfer or monitoring. At this time, the weather satellite picture receiving station project (EE-16) had just been granted funding by the ROK Central Office of Meteorology.

Further, the possibility of holding an international seminar on technology transfer was proposed and discussed favorably.

Phase V Activities

The Korean activities during Phase V were related to institutionalization of the knowledge and experience gained during this program and preparations for its continuation.

Among the steps toward institutionalization was the assignment of responsibility for supervision of continuing technology transfer activities to the Technical Information Department of KIST. Further, the KIST staff has solicited new technical problems from Korean industry, indicating its continuing commitment to the concept of technology transfer.

A list of 14 new problems has been formulated by the KIST staff and submitted to IITRI for processing. Descriptive titles of these problems are listed in Table V, while the complete problem statements are given in Appendix F. These problems have been selected with more care than the original 51 in order to be more certain of finding sponsors among Korean industries once applications engineering has been completed.

TABLE V. Listing of Additional Problems Proposed

P-1	Design principles of active band-pass filters for high frequencies
P-2	Agricultural use of blast-furnace slag as fertilizer or soil conditioner
P-3	Manufacturing process for copper-sleeved aluminium wire
P-4	Design technique for 50 MHz transceiver
P-5	Radiation efficiency improvement of whip antenna
P-6	Ceramic coating for metal
P-7	Technology for solid-waste treatment
P-8	Manufacturing technology of self-lubricating steel bearing by squeeze-casting method
P-9	Stabilization techniques of solid-state microwave sources

P-10	Analysis of radiation characteristics for phased-array antennas
P-11	Explosive cladding of lead plate to steel plate
P-12	Manufacturing technology of a new sheet material for use as the flooring of Korean Ondol room
P-13	Design principles of improved ignition systems for automobile gasoline engines
P-14	Life-testing method for deep-grooved ball bearings

It has been agreed that an international seminar on technology transfer will be held at KIST in November 1972. This seminar will be funded by AID and will include participants from six Southeast Asian nations, the United States, and Korea. Among the presentations will be the results of the present program and a discussion of technology transfer models for developing nations.

III. DISCUSSION AND EVALUATION

On the whole, the program was quite successful in that KIST has developed the capability of technology transfer. As a result, KIST has been able to promote further the concept of research and development to the generally conservative Korean industrial community. The Korean situation is unique among developing nations in that an independent research and development organization exists which can assume the role of active intermediary between foreign technology and domestic industry. KIST, in performing this function, can channel into the Korean economy appropriate technologies specifically adapted to the needs of Korean industry.

The performance of the technical mission to Korea was satisfactory and the objectives established for Phase I were achieved. The mission did an excellent job of informing the Korean personnel about the program and its potential. However, a more complete description of the NASA Aerospace Data Bank should have been presented. It was important to know all the characteristics of the NASA information resources, particularly, that the majority of the data concerned incremental technologies which might not have immediate applicability to the industries of a developing nation. A full understanding of the Aerospace Data Bank would have proven very helpful in the selection of problems and in the subsequent preparation of problem statements and search strategies.

The goals of Phase II were achieved without great difficulty due to the active cooperation of all participants, both American and Korean. However, the execution in a few areas could have been improved somewhat.

First, the seminars delivered by outside consultants during the training visit were broad in scope and considered general aspects of the technology transfer process. Although the KIST team found these presentations interesting, they felt that some of the material was not sufficiently relevant. They would have preferred lectures which dealt with the process of international technology transfer in more specific terms, e.g., detailed description of approaches utilized by existing programs, and discussions of their successes and failures.

Second, the KIST team felt that the U.S. visit was scheduled too tightly. They found it difficult to complete the tutorial activities while trying to evaluate literature search results and attempting to obtain additional information through contacts with NASA centers, contractors, and industries.

Third, the number of problems for which relevant information was

located could have been increased by broadening the scope of the literature searches. Due to the present state of unequal development in Korean industries, the problems proposed by the KIST team required solutions involving technologies at all levels of sophistication. While agreeing that incremental technologies such as those developed by aerospace contractors could provide solutions to certain problems, the team believed that, in the greater number of cases, Korean industries would not be sufficiently advanced to readily apply such sophisticated developments, and package technological solutions must be sought. As a result the literature searches conducted by ARAC encompassed several sources of general technology in addition to the NASA Aerospace Data Bank, and relevant technologies were located for 16 of the 51 problems proposed.

The activities pursued during Phase III were generally successful in meeting the goals of technology follow-up and applications engineering. After evaluating the results of the literature searches, the KIST team chose to concentrate its major activities on problems in one area in order to improve the likelihood of successful transfer. The electronics field was selected for two reasons. First, problems in this field had produced large amounts of relevant information because communication technology has profited greatly from the aerospace program. Second, the electronics industry in Korea is comparatively advanced and thus incremental technology from the aerospace program would be more easily applicable.

The IITRI staff performed yeoman service during this phase of the program by organizing the technology follow-up trips by KIST specialists. In some cases, a significant effort was required to identify and contact the many contractors developing technologies relevant to a given problem and to determine the present location of an original innovator.

All applications engineering necessary to prepare the technical solutions for commercial production in Korea was undertaken by KIST. Within the time frame of the program, applications engineering was completed for each of the four problems selected for intensive follow-up. In addition, applications engineering is continuing on one project (EE-16) which was initially selected for limited follow-up but has since received funding to permit intensive transfer activities.

If the definition of a successful technology transfer includes a firm commitment for commercial production by a Korean industry in addition to completed applications engineering at KIST, then only one successful transfer (EE-1) has been achieved during the time span of this project. The scarcity of commercial commitments is the result of two factors.

One is the general reluctance of Korean industry to enter a market which involves a significant amount of capital investment or risk. This conservative attitude can be overcome only through aggressive salesmanship

by KIST based on the demonstration of successful transfers of technologies to industries whose leaders fully comprehend the economic utility of high-gain ventures under high-risk circumstances.

The other factor was the fact that, due to time limitations, not every submitted problem could be the subject of a complete market analysis to determine whether a commercial sponsor would be available should a technical solution be found. This problem can be eliminated in future transfer activities by requiring a preliminary techno-economic feasibility study with positive result for each project prior to its submission for processing.

The purposes of the fourth phase were evaluation of the program and preparation of reports on its activities. With the submission of this report and its counterpart from IITRI, this phase will have been completed. In total, the evaluation of the program from the point of view of the Korean participants is highly favorable.

The activities described under Phase V for institutionalization and continuation of the program indicate a definite commitment on the part of KIST and the Korean government to international technology transfer. Progress has been made during this program in providing Korean industry with demonstrations of the utility of international technology transfer, the need for industrial research and development, in general, and the ability of KIST to perform these activities.

IV. CONCLUSIONS AND RECOMMENDATIONS

From the viewpoint of the Korean participants, the AID/NASA pilot project in technology transfer has been a distinct success. Five KIST staff members have been trained in the methodology of international technology transfer; lines of communication have been opened between KIST and U.S. sources of advanced technology; and transfer of aerospace-developed technology has been implemented in four problem areas of importance to Korea. As a result, KIST has shown that it is an effective intermediary in the advancement of Korean technology, and the ROK government and industry have become more aware of KIST as an agent of technological change.

However, the program was slightly less effective than envisioned for two reasons. The first was that not every one of the problems initially proposed had been the subject of a techno-economic feasibility study which would have determined whether a solution, if one existed, would be immediately applicable with salutary effect on the Korean economy. This was the result of the limited time available for defining of the initial problem set. It led to the proposal of some problems for which transferable solutions existed but for which implementation activities were not feasible due to the lack of an obvious commercial demand.

The second reason was the limiting of the technical information resources mainly to those available through the NASA Aerospace Data Bank. This usually resulted in the identification of incremental technologies developed by aerospace contractors as possible solutions to problems confronting Korean industries. Although these technologies were relevant to the problems, in many cases, they could not be implemented as the Korean industries are not sufficiently sophisticated. Consequently the likelihood of locating a relevant and applicable technology was distinctly reduced. For the 51 problems submitted by KIST for solution, only 16 had relevant technological information available through the NASA Aerospace Data Bank, and of these 9 were considered candidates for transfer. In four cases immediate application of the technology seemed possible, and applications engineering was undertaken. In the other five, immediate transfer was not considered feasible, and further study was initiated.

The four cases in which transfer was accomplished were all in the field of electronics. Since sophisticated communications equipment is one of the major products of aerospace technology and the electronics industry is one of Korea's comparatively advanced, it would have been resonable to expect a priori that incremental technologies applicable to Korea would exist in this area. However, many industries in Korea are not so modern and would require the transfer of a significant amounts of the basic

technologies common to their U.S. counterparts before they could accept the aerospace-developed increments available through NASA Data Bank.

Although applications engineering on each of the four cases selected for immediate transfer was completed within the program period, a firm commitment for commercial production was obtained in only one case. This lack of commercial sponsorship demonstrates again the necessity of performing a preliminary techno-economic feasibility study for each problem, which would include assessments not only of the commercial market for the transferred technology, but also the degree of industrial interest which can be expected. It also illustrates that aggressive salesmanship on the part of KIST is an integral part of international technology transfer activities. Korean industries must be thoroughly convinced of the economic utility of the foreign technologies KIST has adapted to the needs of Korea before they will commit themselves to commercial production.

On the basis of these conclusions, KIST recommends that the program in technology transfer with dual active intermediaries be continued with the following modifications:

(1) A preliminary techno-economic feasibility study of each proposed problem must be conducted to ascertain whether a solution, if identified, would be immediately applicable with positive economic benefit.

(2) The resources utilized in the search for relevant technologies should include all U.S. technical information sources (open scientific and trade literature, government agency and industrial reports, etc.).

These modifications should improve the likelihood of identifying technologies which are both relevant and applicable to the industries of a developing nation.

APPENDIX A

PHASE I ACTIVITIES

This appendix provides additional details pertaining to the program activities during Phase I. The membership of the U.S. technical mission is given first. This is followed by the mission's itinerary.

MEMBERS OF U.S. TECHNICAL MISSION TEAM

Mr. Henry A. Arnold	Deputy Director Office of Science and Technology Bureau for Technical Assistance AID, U.S. Department of State
Mr. William Littlewood	AID Representative U.S. Embassy, Japan
Mr. Ronald J. Philips	Director Technology Utilization Office National Aeronautics and Space Administration
Dr. Clinton A. Stone	Director Physics Research Division IIT Research Institute
Dr. Joseph Disalvo	Director Aerospace Research Applications Center University of Indiana

ITINERARY OF U.S. TECHNICAL MISSION TEAM

JUNE 1970

June 8th MONDAY	9th TUESDAY	10th WEDNESDAY	11th THURSDAY	12th FRIDAY	13th SATURDAY
AM: Arrive Seoul.	AM: Visit KIST. Luncheon at KIST.	AM: Arrive Pusan. Visit Gold Star Co., Ltd.	AM: Visit Lucky Chemical Industrial Co., Dong Kuk Steel Mill Co.	AM: Arrive Ulsan Industrial Complex. Visit Hankuk Aluminum Refining Co.	AM: Arrive Seoul. Mr. Arnold leaves Korea. Discussion.
PM: Visit AID, MOST.	PM: Briefings at AID, EPB.	PM: Visit Korea Shipbuilding and Engineering Co., Dong Myung Lumber Industrial Co.	PM: Visit Hankun Ceramic Co. Mr. Littlewood leaves Korea.	PM: Reception.	

15th	16th	17th	18th	19th	20th
AM: Visit Kia Industry Co., Chong Kun Dang (Parma-ceuticals) Co.	Discussion with Directors of Korean Industries.	Presentation of NASA Technology Utilization System and Proposed Program.	Continuation of discussions.	Discussion of detailed plans for Phases II-V to allow for Korean comments and participation in final planning.	Team leaves Korea.
PM: Visit Dai Il Chemical Co., Oriental Precision Co., Ltd.	PM: Reception at KIST.	Discussion to establish areas for potential technology transfer and trial problems for Phase II.			

APPENDIX B

PHASE II ACTIVITIES

The purpose of this appendix is to present a more detailed description of the activities of Phase II. First, there is a listing of the members of the KIST technology transfer team and their backgrounds. The second item is a schedule of the team's activities in the U.S. The final item is a listing of the trips made by the individual team members.

MEMBERS OF KIST TECHNOLOGY TRANSFER TEAM

Dr. Young Ku Yoon (Head, Physical Metallurgy Lab. I, Corrosion Lab.):

Material science, Ph.D. (1957-Brown University); former research metallurgist, Argonne National Laboratory.

Dr. Kyung Ho Hyun (Head, Control & Instrumentation Lab., Technical Information Department):

Nuclear engineering, Ph.D. (1967-London University, U.K.); former research engineer, Reactor Equipment Department, The English Electric Company Ltd., U.K.

Dr. Tai Wan Kwon (Head, Food Resources Lab.):

Food technology, Ph.D. (1963-Florida State University); former assistant professor, Iowa State University.

Dr. Young Ok Ahn (Head, Polymer Chemistry Lab.):

Chemical engineering, Ph.D. (1966-Iowa State University); former research engineer, Experimental Station, DuPont Company.

Mr. Joon Woo Nam (Head, Industrial Equipment Engineering Lab.):

Mechanical engineering, M.S. (1960-University of Missouri); former senior engineer, Chicago Technical Center, Continental Can Company.

SCHEDULE OF PHASE II ACTIVITIES IN U.S.

A U G U S T

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
16	17 Dr. Tai Won Kwon arrives at IITRI.	18	19	20	21	22
23	24 Other team members arrive Chicago-settle in housing.	25 AM: Establish Offices, meet Technology Utilization staff. Luncheon with IITRI Director, NASA & staff. PM: Seminar on Technology Utilization Programs.	26 AM: Review data search on presubmitted problems. PM: Team scans pertinent reports.	27 Review and discussion of all problem statements. Individual counseling.	28 Each team member selects three priority problems-begins preparation of final problem statements.	29
30	31 AM: Review final problem statements. Submit to ARAC for search. PM: Review repts. related to presubmitted problems					

S E P T E M B E R

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
		11 AM: Prepare additional or rev. data searches on presubmitted problems. PM: Seminar by outside consultant.	2 AM: Prepare problem statements for non-priority problems. PM: Seminar by outside consultant.	3 AM: Prepare problem statements for non-priority problems. PM: Seminar by outside consultant.	4 Prepare problem statements for nonpriority problems.	5
6	7 HOLIDAY	8 AM: Review problem statements & priority searches. PM: Final statements to ARAC.	9 Seminar by ARAC staff on standard interest profiles, general area search & other services.	10 AM: Selection of prof. & area searches for sub. to ARAC. Rev. priority prob. searches. PM: Seminar by outside consultant.	11 Review priority problem searches.	12
13	14 Visit ARAC and assist in conduct of searches.	15 Visit to ARAC continued.	16 Visit to ARAC continued.	17 Visit to ARAC continued	18 Return to Chicago.	19
20	21 Evaluate and analyze problem searches including reports.	22 Evaluate and analyze problem searches including reports.	23 Evaluate and analyze problem searches including reports.	24 Evaluate and analyze problem searches including reports.	25 Evaluate and analyze problem searches including reports.	26
27	28 AM: Select specific technology for follow-up & poss. visits. PM: Leave for Washington D.C.	29 AM: Visit NASA Headquarters. PM: Visit State Department.	30 Visit RECON. Depart for Lewis Research Center.			

O C T O B E R

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1 Visit Lewis Research Center.	2 Visit Marshall Space Flight Center.	3 Return to Chicago.
4	5 Discuss program elements as they relate to transfer of technology to Korea.	6 Prepare background material for specific technology visits-discussions with ITRI staff.	7 Visits to discuss specific technologies.	8 Visits to discuss specific technologies.	9 Visits to discuss specific technologies.	10
11	12 Discussion of specific technology visits-prepare additional search requests.	13 Discussion of Phase III communication and implementation plan.	14 Discussion of Phase III communication and implementation plan.	15 Discussion of Phase III communication and implementation plan.	16 Depart for Korea.	

TRIPS BY INDIVIDUAL TEAM MEMBERS DURING PHASE II

Mr. Nam: (ME)	9-16-70	Iron and Steel Convention in Cleveland for general information.
	9-22-70	Catepillar Tractor Company in Peoria and Aurora, Illinois to discuss diesel engine technology.
	10-6-70	Carter Carburetor Company in St. Louis, Missouri to get information on technical assistance in the area of carburetor manufacture.
	10-7-70	Marshall Space Flight Center, Huntsville, Alabama to inspect several shop and tooling techniques developed at there.
	10-8-70	Caterpillar Tractor Company in San Leandro, California to observe and discuss the manufacturing process of precision fuel injection equipment for diesel engines.
Dr. Ahn: (CE)	9-23-70	The DuPont Company in Philadelphia to discuss polyurethane-foam technology.
	9-29-70	B.F. Goodrich Chemical in Cleveland to discuss the technology for making clear PVC.
	9-30-70	Battelle Memorial Institute in Columbus to discuss adhesives technology.
	10-8-70	Mobay Chemicals Company in Pittsburgh to discuss low cost plastic materials for housing.
	10-9-70	Building Research Institute, N.B.S., in Washington, D.C. to discuss their work on low cost housing.
	10-12-70	The Upjohn Company in North Haven, Connecticut to discuss their work on polyurethane foams.

Dr. Yoon: (MM)	9-24-70	U.S. Steel Corporation, Research Center in Pittsburgh to discuss silicon steel technology.
	10-7-70	University of Denver, Denver, Colorado to meet with Dr. Art Ezra and discuss his center's work in explosive forming technology; also discussed the possibility of his center's actively participating in the transfer of this technology. (Accompanied by IITRI staff member.)
	10-8-70	General Electric R&D Center in Schenectady.
	10-9-70	New York to discuss tungsten ore processing technology.
Dr. Hyun: (EE)	9-24-70	Westinghouse Electric Company in Pittsburgh to discuss the manufacture of fractional horsepower electric motors.
	9-30-70	Battelle Memorial Institute in Columbus to discuss the operation of their Technical Information System.
	10-6-70	Motorola, Inc. in Schaumburg, Illinois to discuss their work on miniature transceivers. (Accompanied by IITRI staff member.)
	10-8-70	Motorola, Inc. Semiconductor and Government Electronics Division in Phoenix, Arizona to discuss their work on the development of an integrated circuit FM transceiver for the U.S. Marines. (Accompanied by an IITRI staff member.)
	10-9-70	University of New Mexico in Albuquerque to discuss general research on their semi-conductors and radiation effects on semi-conductors. Also visited the Technology Applications Center to see the operation of this particular R&D center.
	10-16-70	Westinghouse Defense and Space Center in Baltimore, Md. to discuss their development of a microelectronic transceiver for NASA. Also, some information was obtained on the manufacture of fractional horsepower electric motors.

Dr. Kwon: (FT)	10-2-70	Louisiana State University in Baton Rouge to discuss the production of single-cell protein using waste products.
	10-7-70	Army Natick Laboratories, Natick, Massachusetts to discuss their work on flexible, retortable food packaging material and compact survival rations.
	10-8-70	Squibb Institute for Medical Research in Newark, New Jersey to discuss research work on continuous fermentation for single-cell protein.
	10-9-70	Iowa State University in Ames, Iowa to give a seminar on protein rich foods.
	10-12-70	Continental Can Company in Chicago to get information on their work in the development of retortable, flexible food packaging material used by the Army Natick Laboratories. The materials were developed by the Continental Can Company and they hold the rights to them.

APPENDIX C

PHASE III TECHNOLOGY FOLLOW-UP TRIPS

This appendix provides additional information on the four technology follow-up trips to the U.S. made by KIST specialists during 1971 as part of Phase III.

The first two visits were made simultaneously. The KIST researchers involved were Drs. Man Yung Chung and Sung Jai Sohn, who were responsible for the transfer of the technologies of miniature transceivers for personal radios (EE-1) and high-sensitivity transceivers (EE-3), respectively. The following is a chronology of their visit.

March 18-19	Drs. Chung and Sohn arrived at IITRI. They were introduced to project staff, who discussed NASA Technology Utilization Program aspects, presented goals and objectives of Korean Program, and discussed background information of Phase II and initiation of Phase III. Individual discussions were held with IITRI project staff and divisional electronic experts to obtain an accurate picture of the problems and the solutions being sought.
March 22-24	Drs. Chung and Sohn attended IEEE convention in New York.
March 25	Dr. Chung attended IEEE conferences, Dr. Sohn and IITRI staff member visited Mr. Edward M. Ulicki, formerly of Simmonds Precision Products, now with Holobeam, Inc., to discuss the design of the PRC-65 radio set. The emphasis of the discussion was on the design characteristics of the phase-locked-loop circuitry and the voltage controlled oscillator.
March 26	Drs. Chung and Sohn and IITRI staff member visited Mr. C.L. Ruthroff at Bell Telephone Labs to discuss his work on the development of an injection-locked-oscillator FM receiver. Also, a visit was made to see Mr. Roger Devantier at RCA/ Defense Electronics Products to discuss their work on the Apollo communications system.
March 29 - April 2	Koreans reviewed information obtained from IEEE conference and technical visits, studied pre-visit documentation of commercial firms producing desired products, held discussions with IITRI project staff and divisional experts on

their additional technical needs, and prepared a proposed list of companies to visit.

April 5 — Drs. Chung and Sohn, with Mr. S. Uccetta (IITRI), visited Mr. Mike Gaudiano in the Microelectronics Section at the Manned Spacecraft Center, Mr. Max Engert and Mr. Bob Hymer of the Instrumentation & Electronics Section and Mr. Lennet and Mr. Fowler of the R.F. Communication Section. Discussions were held concerning the NASA/Westinghouse CLEM block, Westinghouse CLEO block (a proprietary design of Westinghouse), various microelectronic devices designed and built at MSC, the Apollo communication system built by RCA Defense Communication Systems, and high frequency S-band transmitters developed at MSC.

April 6 — The group contacted Mr. Roger Weber at Texas Instruments, Dallas, Texas to discuss the design and development of the PRC-95 transceiver built for the U.S. Navy. Mr. Lewis Claiborne of T.I. was also interviewed regarding his work on a surface wave filter used in the PRC-95.

April 7 — The team visited the Goddard Space Flight Center, Greenbelt, Maryland and met with Mr. John Lyons and Mr. Dave Dargo of the Microcircuit Fabrication Lab, who described their work in the development of P-channel MOSFET digital IC's. Mr. Somerlock and Mr. Robinson were brought in to discuss GSFC's work in the area of phased-locked-loops. Mr. Len Kleinberg was contacted to discuss his work on circuit miniaturization through use of "inductorless" circuits. In addition, the team met with Mr. Walt Nagel to discuss transponders used in weather balloons, and Mr. Y. Sundararajan regarding the Intelsat Satellite System currently under study to broadcast TV to India.

April 8 — The Koreans met with Mr. Steve Glassman, NASA, to discuss the current follow-up activities. Dr. Sohn and Mr. Uccetta visited Page Communication Engineers, Inc. and spoke to Mr. Bill Cleverly in the Transmission Engineering Section regarding their long-range communication projects in the Far East (Indochina) and the Middle East (Iran).

April 9 — Dr. Chung met with a Korean associate working at the Jet Propulsion Labs in Pasadena, Calif. Dr. Sohn met with representatives of the Korea Fine Instrument Co. in New York.

April 12 — The team visited the Jet Propulsion Laboratory and met with

John Drane, Len Sauer, and Jim English of the Technology Utilization group. Technical discussions were held with Mr. Richard Postal who helped develop a tone modulated transmitter for remote activation of police car transceivers. Dr. Chung received detailed technical information on the system and saw a demonstration of the device.

April 13

Dr. Sung Jai Sohn returned to JPL and met with the following individuals: Dr. Edward Posner, Mr. Frank Ott, Mr. William Herd, and Mr. P. Whitney. The topics of the discussions included a description of a past project at JPL to modify U.S. Army transceiver AN/GRC-109 from its existing tube electronics to a solid state design; multiplex communications and data transmission systems used by JPL and possible applications to commercial areas; and specifications and frequency limits of JPL developed microcircuits and IC's.

Dr. Man Y. Chung and Mr. S. Uccetta visited TRW Semiconductor in Lawndale, Calif., to see their hybrid and IC production facility, and obtain technical information on their R.F. transistors, microelectronic active filters, UHF-VHF broadband amplifiers, and other communications equipment components.

Dr. Chung and Mr. Uccetta also met with the president and sales manager of Silicon General Inc. to discuss their "quick chip" breadboard IC. The concept of their product is essentially identical to the NASA/Westinghouse CLEM block. It became apparent in these discussions that this device offers notable advantages over the CLEM block for Dr. Chung's application in terms of versatility, cost, and design requirements for the prototype work on transceivers to be performed at KIST. Dr. Chung received cost information on the "quick chip" and some samples for experimentation.

April 14

The team met with the following individuals at Motorola Semiconductor Products, Phoenix, Arizona: Mr. Chuck Kinard, Mr. Mike Gay, Mr. Dave Burnett, and Mr. Harry Koski. The technical discussions held with these individuals covered integrated circuits for FM-IF amplifiers, micro-discreet low-power devices, voltage variable capacitance diodes for tuning applications, and phase-locked-loop circuits.

April 15

The team met with Mr. Bill Ehlsam and Mr. Ted Hanna of

National Semiconductor, Santa Clara, Calif., to get specific technical information on their integrated circuits and their applicability to Dr. Chung's transceiver development program. Drs. Chung and Sohn obtained specification sheets and applications notes along with numerous samples for study.

The team met with Mr. Jack Taguchi, Mr. Sam Sir, and Mr. John Nichols of Fairchild Semiconductor, Mountain View, Calif., to obtain specifications on their miniature discreet components for R.F.-low power applications.

The team met with Mr. Andy Holmes and Mr. Alan Gregory of the Signetics Corp., Sunnyvale, Calif., to obtain data sheets and discuss the various parameters of their phase-locked-loops, with regard to applications in frequency synthesizers and discriminators in transceivers.

April 16 — The group saw Mr. Wes Wickham of Hewlett-Packard, Palo Alto, Calif., to discuss the capabilities of their instrumentation to measure transistor and circuit parameters. Dr. Chung was especially interested in accessories for a recently acquired spectrum analyzer at KIST.

At this point, Dr. Man Chung departed for Korea and Dr. Sohn remained for another 9 days.

April 19-21 — Dr. Sohn organized, reviewed and evaluated the technical material obtained on the trips, visited a local supplier to purchase additional electronic components for experimentation at KIST, and held some technical discussions with experts both at IITRI and the Zenith Radio Corporation regarding the design and application of surface wave devices.

April 22 — Dr. Sohn and Mr. Uccetta attended a special meeting of representatives of Goddard Space Flight Center, Martin-Marietta, and the University of Wisconsin at GSFC discussing current and future work in the area of inductorless electronic circuits. Martin-Marietta has recently received a contract from the Air Force and LEAA to develop miniature police transceivers using all inductorless circuits. Some sample operational circuits were shown and data sheets on various inductorless circuits were distributed.

April 23-26 — Dr. Sohn completed a preliminary analysis of the technical information obtained on this follow-up trip and requested

additional reports treating some of the topics covered in the personal visits in more detail. Based on an earlier visit with Mr. Ed Ulicki to discuss the design of the PRC-65 radio set, we learned of some additional work being carried on at the Rome Development Center, Griffith Air Force Base, Rome, New York. We visited Mr. Frank North at the center and were shown several designs of transceivers currently under development. Dr. Sohn was very interested in AN/VRC-79 being built by Bendix for the Air Force. This device is an all FM transceiver with 2880 channels incorporating micro-discreet devices and integrated circuits.

April 28 — Dr. Sohn departed for Korea.

The third visit concerned the technology of solid tantalum electrolytic capacitors (MM-4). The following is the schedule of the visit made by Dr. Young Ku Yoon, the KIST staff member responsible for the transfer of this technology.

June 1-3 — Arrived at IITRI, participated in review meeting.

June 4 — Departed for East Coast.

June 7 — Visited Bell Telephone Laboratories, Murray Hill, New Jersey, and met with Mr. D.A. McLean to discuss some publications on development work for tantalum capacitors.

June 8 — Visited the Pfizer Co., Minerals and Pigments Division, Easton, Pennsylvania to obtain technical information on various products.

June 9 — Met with Mr. Neal Dolton, Mr. Roy Miller, and Mr. Mike Maggio of Kawecki-Berylco, Inc., Boyertown, Pennsylvania; discussed the processing of tantalum powder, cost, manufacturing of tantalum capacitor pellets, and suppliers of manufacturing equipment. Dr. Yoon obtained samples of Ta powder and wire for experimentation at KIST.

June 14 — Met with Mr. George Papadopoulas of Cornell-Dubilier, Sanford, North Carolina; discussed manufacturing technology and equipment requirements for producing Ta capacitors; received technical information on Ta pellet production, anodizing chemicals and binder/lubricant in production.

June 15 — Visited Mr. John Eckfeldt and Mr. Bob Marlowe of the Sprague Electric Co., Sanford, Maine; discussed detailed description of the procedures involved in the manufacture of Ta capacitors, specifically the anode and cathode plates; saw production lines in operation and learned of various quality control practices.

June 16 — Met with sales representatives of the General Electric Co., Syracuse, New York.

June 18 — Visited Varo, Military Systems Division, Garland, Texas.

June 21-24 — IITRI

June 25 — Dr. Yoon returned to Korea.

The final trip was made by Dr. Song Bai Park, who was responsible for the transfer to Korea of the technology of inductorless communication circuits (EE-18). This is the choronology of his visit.

June 29 — Dr. Park arrived at IITRI to begin his work on the follow-up of inductorless electronic circuits. Based on previous discussions with Dr. Y. Yoon, Dr. Park's trip was planned to include a study of the technology of a simple and economical smoke detector developed by the McDonnell-Douglas Corp. in conjunction with a NASA project. If found applicable, this technology could be adopted by KIST to make a simple and economical fire alarm under sponsorship of a Korean company which would eventually produce the devices for domestic and export use. Dr. Park would investigate this technology and bring all relevant information back to KIST for detailed study.

June 30 — Dr. Park and Mr. S. Uccetta visited with Mr. Len Kleinberg of the Goddard Space Flight Center. Mr. Kleinberg briefed Dr. Park in detail on the designs and applications of inductorless circuits built at GSFC. Dr. Park studied several circuits which used no inductors and obtained schematics for experimentation at KIST. Stressed at the meeting was the fact that this technology was essentially still experimental in nature and required theoretical analysis to allow practical production applications. Nonetheless, Dr. Park did feel that these circuits offered a high potential for circuit micro-miniaturization and reduced power drain.

July 1	Dr. Park visited a Korean associate at the Electronics Department of Maryland State University and inspected up-to-date instrumentation equipment used to measure circuit parameters. In addition, he visited the COMSAT research and development laboratories to see their micro-electronic fabrication facilities.
July 2	Dr. Park and Mr. Uccetta visited Dr. Wolfgang Gaertner of Gaertner Research Inc., Stamford, Connecticut to discuss his work for Goddard Space Flight Center on computer-aided design, construction, and performance of high-Q micro-power filters for the 100 to 500 MHz range without the use of inductors.
July 6	Dr. Park met with Mr. Gene Jones and Mr. Sam Hartin of the Martin-Marietta Co., Orlando, Florida. (Martin-Marietta was the contractor to the Goddard Space Flight Center who helped to design and eventually fabricated inductorless communication circuits.) Their work in this field was discussed and a very detailed tour of their micro-electronic production facility was given. Dr. Park received a great deal of information on specialized production equipment used in producing hybrid and integrated circuits.
July 7-8	IITRI
July 9	Dr. Park met with Mr. Wes Wickham of Hewlett-Packard, Palo Alto, California to get detailed information on their S-Parameter measurement systems, spectrum and network analyzers, and high frequency instrumentation needed for establishment of an expanded micro-electronics facility at KIST.
July 12	A visit was made to the Electronics Research Branch of Stanford University, Palo Alto, California to inspect their electronics research facilities and to discuss the latest developments in the technology of distributed lines. (Distributed lines is a technique whereby complex circuits can be built in an extremely simplified way by alternating depositing layers of conductive, resistive, and dielectric films in various configurations over a substrate. This topography yields a 3-dimensional circuit network which allows increased reliability and ease of fabrication for complex circuits.)
July 13	A meeting was held with Mr. John Dimeff and Dr. Neigel

Tombs of the Instrumentation Division at the Ames Research Center, Moffett Field, California. Discussions were held regarding the work of a previous staff member, Dr. W. Kerwin, who had performed development studies of distributed line networks. Pertinent technical reports and data were given to Dr. Park.

We met with Mr. John Knudson, Manager of the Microelectronics Fabrication Facility of the Lockheed Missiles and Space Company. Mr. Kundson's group at Lockheed built distributed line circuits under contract to Ames Research Center. Samples of these circuits were inspected and a tour of Lockheed's electronics production facility was given.

In addition, we met with Mr. Bill Mills, Sales Engineering Manager, of Varian Associates, Palo Alto, California to obtain technical and cost information on their vacuum deposition equipment.

July 14

We visited TRW, Semiconductor Division, Lawndale, California and met with Mr. Ken Clancy, Mr. Mike Holkenbrink, and Mr. Howard Knipple. Dr. Park obtained technical specifications and cost data on TRW's "varicap" voltage variable capacitors, modularized amplifier systems for transceivers, active filters, and high frequency semiconductor device.

A visit was made to the Jet Propulsion Laboratory in Pasadena, California to speak with Dr. H. Choi in the instrumentation branch. Technical discussions were held regarding the application of surface wave devices as bandpass filters. JPL is investigating various applications for these devices in their spacecraft electronics and Dr. Chung believes these may be applicable to consumer electronic products.

July 15

We visited the McDonnell-Douglas Corporation, Long Beach, California and spoke with Dr. N. R. Byrd, Mr. Wes Acker, and Mr. Jack Fiskin regarding the application of special solid state gas contaminant detectors built by McDonnell-Douglas to fire alarm systems. It was learned that the feasibility of this application has been shown; however, some R & D work still needs to be performed to develop a workable device for fire applications, namely, (1) identify specific gases and/or contaminants exclusively related to fires; (2) identify and produce a polymer material whose electrical conduction properties are affected by these

gases and contaminants, and (3) design a system with adequate redundancy to be reliable and be protected against false alarms.

Dr. Park would deliver the technical information he obtained to a polymer chemist at KIST for evaluation as to its potential for further development at KIST.

July 16 Dr. Park departed for Korea.

APPENDIX D

PHASE IV ACTIVITIES

This appendix provides further information on the activities during Phase IV. The membership of the program evaluation team is listed first. This is followed by the team's itinerary.

MEMBERS OF PROGRAM EVALUATION TEAM

Mr. Henry A. Arnold	Deputy Director, Office of Science and Technology Bureau for Technical Assistance AID, U.S. Department of State
Mr. Jeffery T. Hamilton	Director Technology Utilization Office NASA
Dr. Clinton A. Stone	Director Physics Research Division IITRI
Mr. Serge Uccetta	Project Manager AID/NASA Pilot Project in Technology Transfer to Korea IITRI
Dr. James R. Blackledge	Associate Director Denver Research Institute University of Denver

PROGRAM EVALUATION TEAM SCHEDULE (April 17-26, 1972)

MONDAY April 17	TUESDAY April 18	WEDNESDAY April 19	THURSDAY April 20	FRIDAY April 21	SATURDAY April 22
	Morning:	Morning:	Morning:	Morning:	Morning:
	Meet Dr. Hahn.	Review Tantalum Capacitor Transfer (MM-4).	Visit Sam Wha Condenser.	Review High-sensitivity Transceivers Transfer (EE-3).	Visit Minister Choi at Ministry of Science and Technology.
	Meet Dr. Hyun.			Review Inductorless Circuitry Transfer (EE-18).	
	Discuss new problems, future information requirements.				
Afternoon:	Afternoon:	Afternoon:	Afternoon:	Afternoon:	
Establish schedule and objectives.	Luncheon at KIST.	Review Miniature Transceivers Transfer (EE-1).	Visit Han Jin Co., Tong Yang Jungmil Co.	Review Weather Satellite Receiving Station Transfer.	
Tour of KIST.	Review evaluation criteria.			Visit to Central Meteorology Office.	

MONDAY April 24	TUESDAY April 25	WEDNESDAY April 26			
Review evaluation criteria and finalize information.	Discussion on program extension.	Brief AID Mission.			
Discussion of limited follow-up items on individual basis.	Summation and review of program results.	Depart.			

APPENDIX E

INITIAL PROBLEM STATEMENTS

This appendix presents statements for the 51 problems defined and processed during Phase II. They are grouped by technical area. First are the 14 problems in Chemistry and Chemical Engineering (CE), next come the 18 problems defined in Electrical and Electronics Engineering (EE), the third group is the 7 problems for Food Technology (FT), fourth are the 5 problems in Mechanical Engineering (ME), and finally the 7 problems in Metallurgy and Materials Technology (MM).

ELIMINATION OF CARBON MONOXIDE

IN ANTHRACITE COAL BURNING

CE-1

WHAT IS NEEDED

An additive, catalytic or otherwise, which can convert carbon monoxide to carbon dioxide or other harmless chemicals during the burning of anthracite coal briquettes.

BACKGROUND INFORMATION

Heating and cooking in rural Korean households is often done by burning coal briquettes. In the winter, the flue gas generated is then used to heat the floor which is covered with vinyl sheets or oil impregnated rice paper. In some instances, the floor covering is such that some flue gas containing CO seeps through the cracks and poisons the person inside the room who can neither smell nor see the minute quantity of escaped gas.

CONSTRAINTS AND SPECIFICATIONS

The additives should either be solids, or liquids of low volatility which can be added to the briquettes during the manufacturing process or prior to burning in the home.

POSSIBLE SOLUTIONS

ARAC has already conducted retrospective searches on "Carbon Monoxide from Anthracite Burning -- The Chemistry of Carbon Monoxides" and "Burning Designs for Reduced Carbon Monoxide Emission." These searches have turned up only methods of CO detection and monitoring and did not uncover methods of prevention.

The present approach should concern itself with searching for catalysts and additives which can convert carbon monoxide to some other non-toxic chemical. We believe this "additive" approach is the most practical since few people in the low income group can afford to change their present heating system -- or use detection devices.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

LIGHTWEIGHT THERMAL INSULATION

CE-2

WHAT IS NEEDED

A low-cost insulation material for rural housing. Specifically this problem can be broken down into three technology information needs:

(1) Generating rigid polyurethane or polyvinyl-chloride foams.

(2) Methods of applying these foams (spray guns, in particular).

(3) Methods of measuring the thermal conductivity of the foams.

BACKGROUND INFORMATION

Korea at present has the technology to manufacture flexible polyurethane foams which are being used for apparel linings and mattresses. This technology can be extended to produce rigid (or semi-rigid) foams for the building industry.

In addition to the information on basic chemicals involved (isocyanates, polyols, blowing agents, catalysts, silicone additives), we would like to know the configuration of the spraying equipment as well as pumping arrangement involved in mixing the various ingredients.

Once the foam is formed either by "pour-in-place" or "spray-on" techniques, it is important to measure the thermal conductivity of this specific type of insulation to determine its effectiveness. Therefore, the search should also include thermal conductivity measurement techniques used with these foams.

POSSIBLE SOLUTIONS

Although polyurethane foams can be used here, polyvinyl-chloride foam is another possibility because of its low cost and availability in Korea.

It should be noted that since these foams are going to be applied to a variety of substrates such as concrete, wood, aluminum and steel, information on primers for surface treatment prior to application of foams should also be included in the search.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

IMPROVED PRESSURE-SENSITIVE ADHESIVES

CE-3

WHAT IS NEEDED

Technology is needed for the production of high-quality adhesives for use in the manufacture of pre-gummed labels and packaging tapes. Specifically, the information on the following technologies is sought:

(1) Formulations for pressure-sensitive adhesives which maintain good tackiness at relatively low temperatures (about -50°C), and which also provide adequate stability at high temperatures (about +40°C).

(2) Formulations for release coatings on paper backings of gummed labels.

BACKGROUND INFORMATION

Pressure-sensitive adhesives are primarily composed of polymeric elastomers, plasticizers, tackifiers, fillers and antioxidants. The proper compounding of these components, and their proper formulation yields adhesives with the desired physical properties.

It is our understanding that the most widely used release coating compound is based on polymethylsiloxane.

POSIBLE SOLUTIONS

Recently the adhesive tape industry has begun to turn from rubber to resinous polymers, acrylic in particular, because of their long term stability when exposed to weather. As we understand, the release coatings for acrylic-based adhesives have not been developed. We do not want to restrict this search to any one particular resin system, but we would like to limit the search to information generated since 1955.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

CLEAR POLYVINYL-CHLORIDE BOTTLES

CE-4

WHAT IS NEEDED

A technology to produce clear polyvinyl-chloride (PVC) bottles is needed. This includes information on compounding PVC resins, plasticizers, heat stabilizers and other additives.

BACKGROUND INFORMATION

The use of clear PVC bottles for packaging a variety of items, including food, is a relatively recent development. Korea can benefit greatly by importing this technology because of the abundant supply of PVC resins available.

Rigid PVC blow-molded bottles are made largely by extrusion or injection molding of a tubular "parison", which is fed while hot directly to a blow-molding machine. Another technique uses extruded sheet which is clamped inside a mold for blowing while in a molten state. Sometimes, it is also possible to weld together two thermo-formed pieces to form a bottle.

If the bottles are to hold beverages or food, the material must not contain toxic components. It is well known that PVC homopolymers, vinyl-chloride/vinyl-acetate copolymers, and propylene/modified PVC copolymers are nontoxic. The surge in the use of PVC bottles was initiated when the FDA approved the usage of an actyl-tin heat stabilizer in PVC processing. More common, but toxic, heat stabilizers include lead, barium, cadmium, strontium, and dibutyl-tin. One also should be careful of the often-leachable plasticizers and impact modifiers.

POSSIBLE SOLUTION

This is an existing, but developing technology. Although clear PVC bottle technology is singled out as an example, we are interested in the plastic food packaging areas as a whole.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

MODACRYLIC FIBER TECHNOLOGY

CE-5

WHAT IS NEEDED

We need information on:

(1) Synthesizing acrylonitrile/vinyl-chloride copolymer which can be spun into fiber.

(2) Methods of wet or dry spinning the above copolymer.

BACKGROUND INFORMATION

Korea is currently active in the manufacture of acrylic fiber, as well as polyvinyl chloride. It is appropriate, therefore, to combine the two raw materials to produce AN/VCL fibers whose consumption for wig manufacturing is increasing rapidly.

The problem with AN/VCL copolymerization is that AN polymerizes much faster than VCL. Therefore, we would like to seek methods of incorporating VCL efficiently into the copolymer so that VCL content is around 40%.

To obtain synthetic fibers with the above polymer with proper hand and curling property, the fibers are formed by wet and dry spinning techniques. Therefore, we would like to learn about the process equipment such as gear pumps and spinning bath, as well as process conditions.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

We are looking for a heavy denier fiber with rough surface contour. It is believed that the longitudinal troughs in the drawn fibers are formed when the solvents in the polymer/solvent mixture either evaporate during the dry spinning process or are extracted during wet spinning.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

ANTIOXIDANT FOR NYLON

CE-6

WHAT IS NEEDED

Antioxidant for nylon which is viscous at high temperatures (200 cps at 100°C).

BACKGROUND INFORMATION

Antioxidant is an essential component in nylon tire cord manufacturing. These antioxidants are blended into the molten nylon polymer before entering spinnerette nozzle. Unfortunately, most antioxidants exhibit very low viscosity at elevated temperatures. The uniform mixing of the additive, therefore, is difficult, and a relatively viscous antioxidant is highly desired.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

Present antioxidant is a condensation product of diphenylamine and acetone. Other additives often used are copper-containing complexes such as copper acetate. Copper complexes are preferred over the amine type because of their light color.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

ADSORBENTS FOR GAS MASKS

CE-7

WHAT IS NEEDED

We need information on:

(1) Synthesizing catalysts that are used in industrial gas masks.

(2) Methods of manufacturing activated charcoal that is used as catalyst support.

BACKGROUND INFORMATION

Although Korea's industrial progress has been rapid, very little attention has been paid to personnel safety. Part of the reason was due to the lack of proper equipment. We believe the development of an industrial gas mask is very essential in this respect.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

HIGH-ALKALI DETERGENTS

CE-8

WHAT IS NEEDED

High-alkali value detergents as additives for diesel (or gasoline) engine oils are needed.

BACKGROUND INFORMATION

A serious air pollution problem in Korea is being caused by the use of low quality detergent-dispersants in diesel and gasoline engine oils. These low quality dispersants are emitted in large quantities from auto and truck exhausts.

A high quality detergent-dispersant is able to decrease the rate of particle formation, provide cleanliness to the carburetor and intake systems, and keep the insolubles in suspension. Thus far, no satisfactory fuel oil additives are being produced to reduce the smog problem.

CONSTRAINTS AND SPECIFICATIONS

Alkali value should exceed 300.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

Possible areas to investigate this problem include:

(1) Alkali or alkali earth metals.

(2) Sulfonates.

(3) Amine phosphates.

(4) Diesel engine oils.

(5) Gasoline engine oils.

(6) Lubricating oils.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

HYDROGEN PEROXIDE

CE-9

WHAT IS NEEDED

Manufacturing technology of hydrogen peroxide used for textile bleaching and polymerization initiation.

BACKGROUND INFORMATION

Korea's textile industry uses large quantities of aqueous hydrogen peroxide. Adhesives and resin makers also use a 30% solution as an initiator. Domestic production of this chemical is very essential.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

FREON

CE-10

WHAT IS NEEDED

Manufacturing technology of the fluorochlorocarbon organic chemicals, commonly known as "Freon", that are used for refrigeration and as aerosol propellants.

BACKGROUND INFORMATION

Korea has reasonably abundant supply of high grade fluospar ore from which these chemicals are produced. Domestic production of this chemical would not only decrease the dollar outflow but also would form the basis of a new export industry.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

FIBER-REINFORCED PLASTICS

CE-11

WHAT IS NEEDED

Fabrication technology of glass-reinforced unsaturated polyester resins.

BACKGROUND INFORMATION

More and more fiber-reinforced plastics are being used in boat construction, fishing rods and furniture. Since these are current or potential export items, the development of this technology is essential.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

BALL EXPLOSIVES PROCESS

CE-12

WHAT IS NEEDED

Technology to produce "Ball Powder" explosives is desired.

BACKGROUND INFORMATION

The ball process was developed originally as a means of obtaining a safe, stable products for small-arms. The process is carried out in many steps beginning with the dissolving of nitrocellulose in suitable solvent. Incorporation of stabilizers and modifiers is followed by the formation of protective colloid. Information in this area can assist Korea's explosives industry greatly.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

REFLECTIVE PAINTS

CE-13

WHAT IS NEEDED

Coatings formulation for a paint with high light reflectance.

BACKGROUND INFORMATION

Reflective paints differ from the other paints in that they contain solid filler materials that can reflect the incident light. The search should also include other constituents of the paint formulation such as vehicle, plasticizers and pigments, although they should not be too different from the conventional compositions.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

These reflective paints are often used in severe outdoor environments. The vehicles used for the paint formulation, therefore, should have good weatherability. In this respect, polymethyl-methacrylate polymer is a good candidate. If these paints require special spraying equipment for application, the search should include this.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

FLAME RETARDANTS AND ANTISTATIC ADDITIVES

CE-14

INTRODUCTION

Use of additives to impart flame retardancy to fabrics, wood and plastics is growing rapidly throughout the world. Prevention of unexpected explosions and personal discomfort by the use of antistat in plastics, carpets and fabrics is also very important.

STATEMENT OF THE PROBLEM

The flame retardancy and antistat property can be incorporated into the plastics or fibers either by modifying the raw material itself or by physical mixing with additives. In Korea, we should concentrate on the additives approach due to the smallness of the market.

We would like to know the method of synthesis of the additives as well as the method of formulating them into the base material. More specifically, we foresee a very large market by concentrating on:

(1) Flame retardants for polyvinyl chloride.

(2) Flame retardants for polyurethane foam.

(3) Antistat additives for polyethylene, nylon, polypropylene and polyesters.

(4) Flame-retardant coatings for wood.

POSSIBLE APPROACHES

At present, the following flame retardants are widely used:

Additive	Consumption in U.S. (Million lbs)
Phosphate ester, non-halogenated	50.7
Phosphate ester, halogenated	9.5
Antimony oxide	16.0
Boron compounds	1.7
Chlorinated compounds	14.0

Many of the antistat agents are proprietary in nature and are known by trade names only. In general they are amines (73%), quarternary ammonium compounds (10%), phosphate esters (5%), or polyethylene glycols (5%). One good example is Armour Industrial Chemical's Antistat 310, an N, N-bis 2-hydroxyethyl alkyl amine.

FOR FURTHER INFORMATION

Please contact: Y. Ahn
KIST Project Team

MINIATURE TRANSCEIVERS FOR PERSONAL RADIOS

EE-1

WHAT IS NEEDED

Smaller transceivers (perhaps using monolithic integrated circuits) are needed for both an existing FM paging system (Bell Boy System) and the next generation of microminiaturized citizen band transceivers (AM).

BACKGROUND INFORMATION

The Bell Boy System consists of an FM receiver with selective calling devices. If smaller monolithic FM receiver circuits are utilized in this system, the receiver can be marketed as a mobile telephone for popular use.

Citizen band transceivers utilize an AM system. In principle, monolithic circuits are not adapted to AM transmitter circuits since it is not possible to integrate a modulating transformer on a monolithic wafer. However, by using voltage variable capacitance (VVC) diodes instead of the transformer[1], AM transmitter circuits can be integrated on a monolithic wafer[2]. Monolithic AM transmitter and receiver circuits may be help in establishing the next generation of microminiaturized citizen band transceivers.

At present Korean manufacturers are producing citizen band transceivers using conventional discrete components for domestic market. These products are not suitable for export since neither new design nor new technology are involved. If the above mentioned new circuits and manufacturing technology are available to Korean industry, they will be able to export these transceivers.

CHARACTERISTICS OF THE PROBLEM

The essential characteristic is as follows:

Layout of the FM and AM receiver circuits using monolithic IC and VVC diodes and having the following specifications:

Input power	1 - 10W
Coverage	1 - 10 miles
Frequency band	1, 27, 50, 250 MHz $\pm$ 5 KHz.

REFERENCES

(1) Chung, M.: "Modulated Quartz Oscillator" U.S. Pat. No. 3622914

(2) Strull, G., et al.: ISSCC Digest of Technical Papers, p. 114 (Feb. 1966)

(3) Donaldson, J.D.: Proc. NEC, 23, p. 297 (1967)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

LEAD-CALCIUM ALLOY MANUFACTURING TECHNOLOGY FOR ELECTRIC BATTERY PLATES

EE-2

INTRODUCTION

Lead-antimony alloy (Pb with 5-12 per cent Sb) has long been used as battery plates. Antimony, which is rare metal and mostly produced by Red China and Bolivia, has become scarce in the Far East recently. Due to scarcity of the metal, the price has ranged from $1,000 to $2,000 per ton in 1969 and sharply increased to $9,800 per ton in July 1970. Even at this 1970 price it is very difficult to obtain antimony metal at the present time.

In this situation, it is necessary to find an alternative material to replace antimony metal for battery plates. A possible solution is to replace lead-antimony alloy by lead-calcium alloy (or a calcium equivalent).

STATEMENT OF THE PROBLEM

Manufacturing technology of lead-calcium (or calcium equivalent) alloy for battery plates.

The essential characteristics of the alloy used for the plates should be as follows:

(1) Tensile strength greater than 400 kg/cm^2.

(2) Resistant to attack by sulphuric acid.

INFORMATION REQUIRED

(1) Lead-calcium (or calcium equivalent) alloy manufacturing process.

(2) Data of the various characteristics of the alloy, such as;

(a) Volume resistivity (ohms-cm).

(b) Specific gravity

(c) Tensile strength (kg/cm^2)

(d) Compressive strength (kg/cm^2)

(e) Thermal expansion ($\Delta l/l$ /°C)

(f) Durability in H_2SO_4 solution

(g) Maximum usable temperature.

(h) Weldability.

BACKGROUND INFORMATION

Calcium metal is employed as an alloying agent in aluminum, in bearing metals of lead-barium-calcium type, in the production of the age-hardening lead alloys for cable sheaths, among other related uses.

The solid solubility of calcium in lead is of the order of 0.1 per cent at the melting point and decreases rapidly to the order of 0.01 per cent at ordinary temperatures*, so that precipitation hardening occurs.

REFERENCE

Hampel, Clifford A.: "Rare Metal Handbook," p. 23,
Calcium, application

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

HIGH-SENSITIVITY TRANSCEIVERS

EE-3

WHAT IS NEEDED

To minimize power consumption of communication systems, high-sensitivity modulation and demodulation systems for a portable transceiver are needed.

BACKGROUND INFORMATION

The most important problem of a portable transceiver used in a communication system is to minimize power consumption. In order to meet this requirement, special modulation and demodulation systems should be developed. In a wireless communication system with a single channel, narrower band width is continuously needed to achieve higher-sensitivity communication systems. The design trends in space-age receivers using phase-lock techniques are setting new records for their superior sensitivity. New design and technology are required to improve the existing portable transceivers using the above technique.

STATEMENT OF THE PROBLEM

The essential problems are as follows:

(1) Modulation and demodulation methods for high-sensitivity portable communication systems.

(2) Circuit layout of the transceiver having the following specifications:

Input power	1 - 10W
Coverage	1 - 10 miles

Frequency	50, 250 MHz
Band width	less than 5 KHz
Stability	better than 0.005 per cent.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

AN INDICATING INSTRUMENT TO SPECIFY THE CHARGE STATE OF SECONDARY BATTERIES

EE-4

WHAT IS NEEDED

A simple indicator to monitor the charge state (or percentage of discharge) of secondary (rechargeable) batteries.

BACKGROUND INFORMATION

As the cycle life of most types of secondary batteries is critically dependent on the discharge depth in each discharge-charge cycle, some simple indicating instrument to determine the charge state is needed for the most effective usage of these secondary power sources. Moreover, such indicators would be of great assistance in deciding when to replace or recharge the batteries in a critical situation as in a space vehicle or in field operation. This is also directly tied to the evaluation of energy capacity of the batteries, and hence, to the problem of quality control in the manufacturing processes. The conventional method is the complete discharge testing of randomly selected samples.

POSSIBLE APPROACHES

(1) Correlation of electrostatic capacity to the remaining charge of the batteries.

(2) Rate of voltage increase due to momentary heavy charging current, or the rate of voltage decrease due to momentary heavy discharge.

(3) Forward and backward impedance.

(4) Alternating current impedance.

(5) Chemical composition changes of the electrolyte.

(6) Some simple integrating coulomb-meter to indicate the amount of charge or discharge.

CONSTRAINTS AND SPECIFICATIONS

(1) Instantaneous indication, preferably an electrical signal.

(2) Applicable to nickel-cadmium and lead-acid batteries.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING OF SOLAR CELLS FOR A SMALL POWER SOURCE

EE-5

INTRODUCTION

In a lighthouse on an offshore isle, discharged batteries may be replaced with new ones brought from a near harbor. When the distance between the lighthouse and the harbor is great, this conventional method becomes quite uneconomical. A new method of charging the batteries is needed. Use of solar cells is the attractive technique for filling the need.

STATEMENT OF THE PROBLEM

Characteristics of the solar cell charging system are as follows:

(1) Capacity of battery: 8-15 watts.

(2) Output voltage: 6 volts or 12 volts.

(3) Requires no maintenance for a period of at least two years.

(4) Long life (more than 6 years).

(5) Usable in wet atmosphere.

INFORMATION REQUIRED

(1) Characteristics of raw materials used for solar cell.

(2) Design and manufacturing technology.

(3) Testing methods of conversion efficiency (solar energy-electrical energy).

BACKGROUND INFORMATION

The cost of producing and/or using solar cells would be high but competitive as the special power source required for use in remote areas (a communication system or an unmanned lighthouse). There are many unattended lighthouses in Korea and boat trips to the remote isles are made frequently to replace the discharged batteries.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

NON-DESTRUCTIVE TESTING BY MICROWAVE

EE-6

WHAT IS NEEDED

Technical details of non-destructive testing by means of microwave techniques.

BACKGROUND INFORMATION

Several ways of non-destructively testing metals and solid masses include the use of X-ray and gamma-ray transmission, and ultrasonic radiation. It has been speculated that the microwave scattering could also serve the purpose and overcome the limitations of some of the conventional methods. A brief description in "Summary Descriptive Information on a Random Selection of Transfer Examples" March 1969 (NASA Headquarters) indicates that this indeed has been proved feasible and put to practical use. We would like to look into the feasibility of adapting this technique in the Korean industry.

CONSTRAINTS AND SPECIFICATIONS

We need the technical details of non-destructive testing by microwave which should include:

(1) Principles, actual performance data, and applicable range of the method.

(2) Microwave generator needed, and the method of detection and analysis.

(3) Specifications of the instruments needed.

(4) Estimate of the cost to set up such a system.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

SOLID-STATE DISPLAY DEVICE FOR DESK CALCULATORS AND DIGITAL INSTRUMENTS

EE-7

WHAT IS NEEDED

Advanced solid-state devices to replace Nixie tubes in light weight desk calculators and digital instruments.

BACKGROUND INFORMATION

With the advent of semiconductor and integrated circuit technology in the manufacturing of digital instruments, these units have become much lighter, more compact, and more reliable, while the power consumption has been drastically reduced. One of the most serious drawbacks of the further miniaturization has been the numerical display devices. The conventional "Nixie" tube is now being rapidly replaced by many types of newly developed solid-state display devices. With advanced semiconductor technology, the production cost of the new devices can be lowered to the level of the conventional electron tube types. The reduction in the electrical power consumption for these semiconductor units would offset the price difference for most applications even at this stage. The world market for all solid-

state digital instruments is expanding very rapidly. The Korean electronics industry is now beginning to enter into this new field. The acquisition of these solid-state display devices and their manufacturing techniques is a key to the advance and growth of Korean industry into this new field.

CONSTRAINTS AND SPECIFICATIONS

The new devices should meet the following requirements:

(1) To be operated at or below 25 volts.

(2) The power consumption must be less than 100 milliwatts per digit.

(3) The associated circuitry should be compatible to planar technology for mass production.

(4) The numerical display should be easily readable in the daylight with suitable filter screen.

(5) These should be reliable and have sufficiently long lifespans.

POSSIBLE APPROACHES

(1) GaAs:P or GaAs:Al diode chips which emit light in the visible (red) region of the spectrum.

(2) Visible light emission in liquid crystals.

(3) The best arrangement of discrete light dots.

(4) The minimum number of light dots per digit for discriminating the numerals.

(5) Increased efficiency in the electrical-to-light energy conversion.

(6) Electroluminescent panel display devices.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

A number of new materials and new processes are being developed and improved in the wide sector of electronics research laboratories. However, the latest production method for the units currently being adopted in the NASA space instruments will suffice.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING TECHNOLOGY OF AL-FOIL CONDUCTOR

EE-8

WHAT IS NEEDED

There is a strong need for a suitable aluminum-foil conductor to be used in an aluminum-foil-wound transformer, which is attractive because of its low production cost. The manufacturing technology for an aluminum-foil conductor with insulating oxide film is needed along with a technique to join coated aluminum foil with negligible contact resistance.

BACKGROUND INFORMATION

Copper conductors in electric machines and equipment can be replaced by the low-cost aluminum-foil conductors suitably coated with insulating film. A typical application of an aluminum-foil conductor is an aluminum-foil-wound transformer. Compared with the conventional transformer, the aluminum transformer has the following advantages:

(1) Production cost is low.

(2) Weight to power capacity ratio is low, hence suitable for transportation system.

Many aluminum transformers, which were manufactured during the Second World War, are still in use on power distribution lines in several countries.

CONSTRAINTS AND SPECIFICATIONS

Aluminum-foil conductor to be developed should meet the following criteria:

(1) Melting point: Not less than 660°C.

(2) Electrical resistivity at 20°C; 3.0 micro-ohms/cm.

(3) Temperature coefficient of resistance at 20°C: less than 0.004 Ω/°C.

(4) Density at $20^{\circ}C$: $2.7\ g/cm^3$.

(5) Coefficient of linear expansion: $23 \times 10^{-6}/^{\circ}C$.

(6) Minimum average tensile strength: $20\ kg/mm^2$.

The coated dielectric oxide film should meet the following criteria:

(1) Volume resistivity: greater than $10^{16}\Omega cm$.

(2) Withstand voltage between each winding at $95^{\circ}C$: 25 volts.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

LADDIC TECHNIQUES

EE-9

WHAT IS NEEDED

Needed are the design and fabrication techniques of laddic with the information about magnetic materials having rectangular B-H loops.

BACKGROUND INFORMATION

Magnetic material with a rectangular hysteresis loop is used for a memory core and in many logic circuits. A magnetic device such as laddic is suitable for any logic circuitry where high reliability is required.

The laddic is an abbreviation for ladder-logic. It consists of a ferrite slab which has evenly spaced apertures like a ladder. Both sides of the ladder and all of the rungs are equal in their cross section so that all of the flux paths have the same flux limitation.

Any Boolean function can be realized by this structure and the windings between cores in conventional core circuitry are not needed due to the magnetic linkage between each flux path.

CONSTRAINTS AND SPECIFICATIONS

The essential characteristics should be as follows:

(1) Switching speed should be shorter than 1μ sec.

(2) Threshold magnetic field for switching should be as low as possible - say lower than 0.1 oersted.

(3) Squareness ratio of the material B_{rem}/B_{sat} should be over 0.9.

(4) It must be operated at temperatures below 165°F.

(5) The material should be homogeneous in its characteristics.

APPLICABLE PRINCIPLES

(1) Applications or recently developed magnetic material with good squareness of B-H loop.

(2) New technology of powder metallurgy process to produce such a device.

REFERENCES

(1) Gianola, U.F. and Crowley, T. H.: "The laddic-a magnetic device for performing logic" Bell Systems Technical Journal, 38, p. 45 (Jan. 1959)

(2) Weaving, A. H. and Sherlock, J.: Reactor electronics

(3) "Magnetic logic applied to reactor safety circuits" J. Brit. Nucl. Energy Soc., p. 74 (Jan. 2, 1963)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING TECHNOLOGY OF

FRACTIONAL HORSEPOWER MINI-MOTOR

EE-10

WHAT IS NEEDED

There is an urgent need for a fractional horsepower mini-motor to be used as a driving device in various electrical equipment and apparatus.

BACKGROUND INFORMATION

Fractional horsepower mini-motors are frequently used for many kinds of electric-driven equipment. Very popular applications of these motors (d.c. motors and universal motors) include portable drills, food mixers, vacuum cleaners, sewing machines, home motion-picture projectors, electric shavers, and business machines of all kinds.

Manufacturers of electric motors in Korea are trying to develop a lightweight d.c. mini-motor for the above applications. Several attempts were made to manufacture the motor. Their attempts, however, were unsuccessful due to a lack of manufacturing technology.

SPECIFICATIONS

Design and manufacturing technology of fractional horsepower mini-motor are required. The mini-motor (d.c. motor and universal motor) should meet the following criteria:

(1) Output ranges from 0.1 watt to 10 watts.

(2) The permissible temperature rise less than 75°C.

(3) Lightweight yoke.

(4) Rated voltage 1.5V ~ 9V.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

A METHOD FOR DETERMINING THE USEABLE ENERGY OF PRIMARY BATTERIES

EE-11

WHAT IS NEEDED

A simple indicator to specify the remaining useable amount of electrical energy in dry batteries in prolonged storage or in a partially used state.

BACKGROUND INFORMATION

Due to the shelf life characteristics of dry and other primary batteries, untold numbers of still useable units are summarily discarded after an indicated period of storage. Uncertainity in the useable life has been one of the most serious difficulties in the utilization of dry batteries in portable instruments and field communication gear. Some indicator of the remaining electrical power of such batteries will eliminate the uncertainties and minimize the apparently senseless waste of these resources. Such an indicator is also of great importance to quality control in the manufacturing processes of primary batteries. It is directly tied to the efforts at increasing the capacity, and hence, the energy density, and at improving the shelf life characteristics. At the moment, the only available method is the random sampling of the batteries for complete (destructive) discharge testing.

CONSTRAINTS AND SPECIFICATIONS

For the practical purpose stated above, the indicator has to be:

(1) Simple to operate.

(2) Instantaneously indicating.

(3) Simple to construct and portable (compact and lightweight for field use).

(4) Applicable to dry battery testing.

POSSIBLE APPROACHES

The following electrical characteristics (other than open-circuit voltage) could be correlated to the remaining electrical energy:

(1) Forward and backward impedance of the primary batteries.

(2) The rate of voltage increase when subjected to momentary reverse (charging) current, or the rate of voltage decrease during momentary discharge.

(3) Some simple integrating coulomb-meter to indicate the amount of electrical energy drawn out.

(4) Alternating current impedance.

(5) Chemical composition changes in the electrolytes.

CHARACTERISTICS OF THE RELEVANT TECHNOLOGY

Until now the cost of the dry batteries has been so low that the effort to squeeze out the last bit of energy has been neglected, and the problem has been circumvented by oversupply. However, redundant supply is not always possible, particularly in space environment and during field exercises. Further, the position of the primary batteries as an expendable power source in low-cost portable instruments for many purposes is here to stay. The new technique will lead to the information on the optimum rate of discharge for various types of primary batteries, and hence, to the information on the best selection of the types of batteries for specific applications.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

TECHNOLOGY FOR ELIMINATION OF STATIC ELECTRICITY DUE TO FRICTION

EE-12

WHAT IS NEEDED

An efficient method of eliminating static charge buildups from printing presses and paper.

BACKGROUND INFORMATION

Workers in printing shops are often exposed to dangerous static electricity charges, generated by friction between the printing machines

and the paper. Methods of grounding the machines and methods of chemically spraying the paper have been used to eliminate the static charge buildup. However, because of uniform charge distribution on fibers and machines, grounding is not always effective. Preventive measures such as chemically spraying and the use of radioisotopes have so far proved to be too costly.

CONSTRAINTS AND SPECIFICATIONS

The only constraint on the static charge removal technique is that it should be low in cost, and relatively simple to implement.

POSSIBLE APPROACHES

Some ideas for approaches are listed as follows:

(1) Discharge methods

(a) Resistance grounding

(b) Radioisotope utilization

(c) Other types of charge removal.

(2) Charge preventive methods

(a) Direct spray of chemicals

(b) Chemical treatment of printing inks, etc.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

HIGH-VOLTAGE/HIGH-CURRENT PULSE GENERATOR

EE-13

WHAT IS NEEDED

A circuit design for a low cost, high-voltage/high-current, solid-state pulse generator, for electronic component testing.

BACKGROUND INFORMATION

Quality control testing of voltage tolerances and insulation strength for electronic components is urgently needed in the Korean electronics industry. Conventional high-voltage/high-current pulse generators of the tube variety are too bulky and too costly to be accessible to the average production plant. It is felt that with the recent advances in semiconductor technology, a high-voltage/high-current pulse generator could be produced with the simple design and low cost necessary for utilization by the Korean electronics industry.

CONSTRAINTS AND SPECIFICATIONS

A circuit design for the pulse generator should meet the following requirements:

(1) Pulse shape: square wave.

(2) Pulse height $\geq$ 500 volts.

(3) Current capacity $\geq$ 10 amps into 50Ω load.

(4) Pulse rise time $\leq$ .3 nanoseconds.

(5) Pulse width: From 1μ sec. to 1 m sec.

(6) Duty cycle: Approximately 100 pulses/sec.

(7) Construction: Low cost, portable, preferably solid-state (fewer than 10 active components).

(8) Special features: Automatic turn-off after preset number of cycles or specified period of time.

POSSIBLE APPROACHES

(1) Use of silicon controlled rectifier (SCR) or silicon controlled switches (SCS) with suitable turn-off circuits, and good wave-shaping arrangements.

(2) Use of high-voltage power transistors utilized in avalanche mode of operation.

(3) Use of unijunction transistor (UJT) for control of timing cycles and durations.

(4) Use of electron tube-type thyratron with good turn-off characteristics.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

As the above kind of portable pulse generator has wide range of applications in the space vehicle experiments, we are fairly sure NASA must have developed such a unit.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

SMALL ELECTRICAL POWER SOURCES

FOR REMOTE OFFSHORE ISLES

EE-14

INTRODUCTION

The existing power sources in lighthouses are not suitable for the remote untenable places. It is needed to replace the conventional source in a lighthouse of an offshore isle with a new, reliable, and long-lived power source. Use of a radioisotope power source coupled to a thermo-electric converter represents the attractive technique for filling the need.

STATEMENT OF THE PROBLEM

The following requirements should be met by the electrical power source for a remote unattended lighthouse:

(1) Capacity of 20W (e).

(2) Output voltage should be 12 volts.

(3) No maintenance required for a period of at least two years.

(4) High reliability.

(5) Long-life (more than 5 years).

(6) Light weight.

(7) Inherent safety.

APPLICABLE TECHNIQUES

There is a growing need for reliable long-life electrical power supplies at remote locations. Applicable energy supplies include batteries, fuel cells, nuclear, combustion, and natural sources such as wind, wave, and solar energy. A radioisotope-fueled generator is generally attractive where power is required continuously for more than a year with little or no maintenance and no fuel replacement. Radioisotopes such as Co^{60}, Sr^{90}, Cs^{137}, and Pu^{238} having sufficiently long half-lives may be considered as heat sources.

BACKGROUND INFORMATION

The radioisotope thermoelectric generator can be lighter than the alternate power supplies; its cost is rather high but competitive for the special applications of several years duration where maintanance is unrealistic and high reliability is necessary.

Currently used power sources such as batteries and combustion generators require occasional or continuous attendance and frequent regular maintenance or fuel replacement.

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FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

LOW-COST ELECTRICAL UTILITY POLE

EE-15

WHAT IS NEEDED

There is a need for design and manufacturing technology of a low-cost electrical utility pole. If a solution is found, this low-cost pole will be used for electrical distribution lines. By replacing a heavy concrete pole with a light low-cost pole, the program for rural electrification will be accelerated.

BACKGROUND INFORMATION

At the present time, a concrete pole (hollow, tapered cylinder) is used to support electrical distribution lines. The pole is expensive to manufacture and difficult to handle. Specifications for the concrete pole currently used in Korea are found in the Appendix.

CONSTRAINTS AND SPECIFICATIONS

The new pole should meet the following requirements:

(1) Dimensions similar to those of existing poles.

(2) Equivalent or better mechanical strength for loading.

(3) Lighter weight.

(4) Lower cost.

(5) Equivalent or longer life.

FOR FURTHER INFORMATION

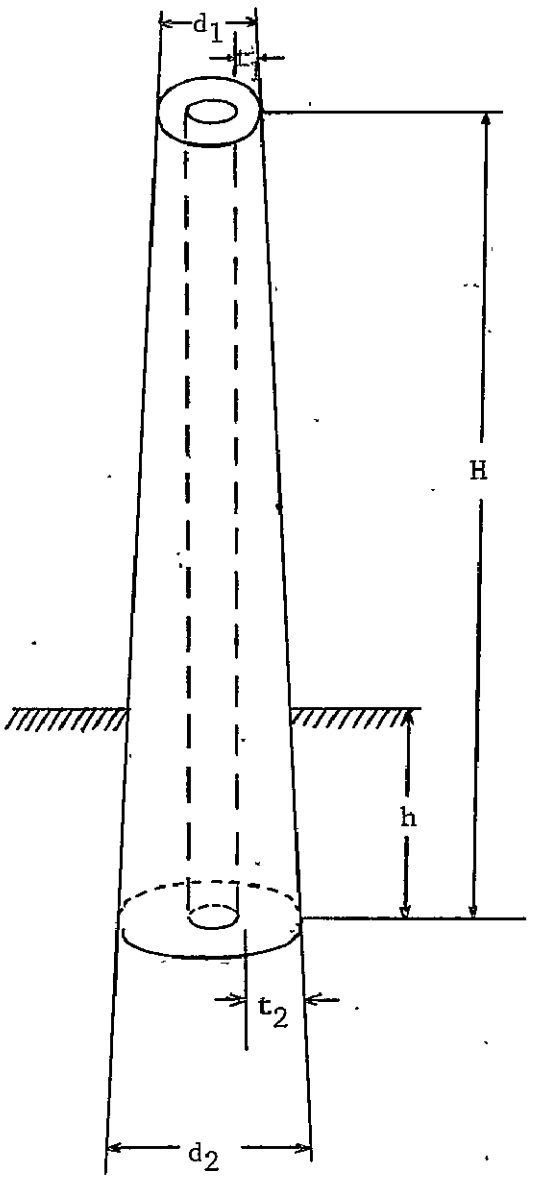
Please contact: K. H. Hyun
KIST Project Team

APPENDIX

Cylindrical Concrete Poles for Power Transmission and Distribution

(1) Shape of concrete pole

Shape of concrete pole is shown in Figure 1.



Dimension of hollow-cylinder concrete pole:

d_1 = the upper end outside diameter

d_2 = the lower end outside diameter

t_1 = the thickness of the upper end

t_2 = the thickness of the lower end

H = the total height of concrete pole

h = the underground height

Figure 1. Shape of a cylindrical concrete pole

(2) Classification of concrete pole

Concrete poles are generally classified in three types, as follows:

Type 1 - Poles for rural electrification use

Material:	Concrete only
Total height:	H = 6-9 meters
Underground height:	h = 1.2-2.0 meters
Total weight:	200-500 kg

Type 2 - Poles for general distribution line use

Material:	Concrete in most cases
Total height:	H = 8-16 meters
Underground height:	h = 1.2-2.5 meters
Total weight:	500-1,680 kg

Type 3 - Poles for transmission line use

Material:	Steel-reinforced concrete
Total height:	H = 10-17 meters
Underground height:	h = 1.7-2.5 meters
Total weight:	760-2,200 kg.

A detailed dimension chart is given in Table 1.

(3) Loading of concrete pole

(a) Concrete pole is loaded with its self-loading weight and with the weight of transformers.

(b) Self-loading is the major portion of the loading being about 75% of the total.

(c) Average weight of pole transformer versus power capacity is shown in Table.2.

(4) Required characteristics of concrete pole

(a) Strength of material

Compression strength: Greater than 450 kg/cm^2

Destruction load: Greater than (2 x designed load)

(b) Crack tolerance

Crack limits under designed load: Within 0.25 mm

Crack limits after removing load: Within 0.05 mm.

TABLE 1. Concrete Pole Standards in Korea

Classification	H (m)	Diameter & Thickness (mm)				Total Weight (kg)	Price (US$)
		d_1	d_2	t_1	t_2		
Rural Electrification	6	120	200	40	50	200	18.5
	7	120-140	213-233	40	50	230	23.5
	8	140	247	40	50	425	30
	9	140	260	40	50	500	38.5
General Distribution Line	8	170	277	40	50	500	37
	9	170	290	45	55	600	50
	10	170-190	290-323	45	55	690	50
	11	190	350	45	55	870	73
	12	190	350	45	55	960	83
	14	190	377	50	60	1,360	120
	16	190	403	50	60	1,680	163
General Transmission Line	10	190	323	45	55	760	64
	11	190	350	45	55	920	73
	12	190	350	45	55	1,100	85
	13	190	350	45	55	1,250	110
	14	190	377	50	60	1,400	130
	15	190	400	50	60	1,540	160
	16	190	403	50	60	1,720	180
	17	190	416	50	60	2,200	200

Source: Dong-A Concrete Manufacturing Co., Ltd.
Korea Electric Co., Ltd. (Sept. 1970)

TABLE 2. Average Weight of Pole Transformer vs. Power Capacity

Rated Capacity of Transformer		Primary Voltage	Secondary Voltage	Average Weight
Rural Electrification	3 KVA	3,300/6,600 (v)	115/230 (v)	68 (kg)
	5 KVA	"	"	82
	7.5 KVA	"	"	98
	10 KVA	"	"	117
General Distribution	15 KVA	"	"	145
	20 KVA	"	"	180
	30 KVA	"	"	235
	50 KVA	"	"	345
	75 KVA	"	"	455

Source: Korea Electric Co., Ltd. (Sept. 1970)

CONSTRUCTION OF AUTOMATIC PICTURE TRANSMISSION GROUND EQUIPMENT FOR WEATHER SATELLITE PICTURE RECEIVING STATIONS

EE-16

STATEMENT OF THE PROBLEM

It is desired to construct economical Automatic Picture Transmission (APT) ground equipment for weather satellite picture receiving stations.

BACKGROUND INFORMATION

Since the launch in December of 1963, of TIROS III, the first APT equipped satellite, the United States has orbited the ESSA and NIMBUS Satellites which transmit pictures of the conditions in the earth's atmosphere. The information contained in these pictures provides an

invaluable assistance to weather forcecasting. The APT system enables ground stations anywhere on the earth to receive instant weather information both day and night, and APT ground stations have already been constructed in many nations.

The APT ground receiving system consists of a remotely position-controlled antenna, an FM receiver, a signal processor and a display unit. The display unit may be a CRT with a camera or a facsimile. A DRIR (direct readout infrared radiometer) adaptor is essential for receiving night-time pictures, but a tape recorder for playback and storage is optional.

Information on an inexpensive way of constructing this APT receiving system is available from NASA (Ref. 1). Based on this information, some makers including EMR Aerospace Sciences presently manufacture APT photo receivers (Ref. 2).

The Meteorological Observatory of Korea has APT receiving equipment which, however, does not include the DRIR unit and, hence, is unable to receive the night-time pictures. They have asked KIST to construct for them one APT photo receiving system for use in a local weather station. KIST considers it as a good opportunity to learn all the relevant technology by utilizing the NASA information.

A POSSIBLE APPROACH

To carry out the present project, the following steps are considered:

(1) Purchase from EMR Aerospace Sciences, one APT Photo receiver with the DRIR unit but without the antenna system.

(2) Construction of spare cards of the electronic circuits including the FM receiver circuit, the signal processing circuit and the DRIR circuit.

(3) Construction of a remote-controlled antenna system.

(4) Construction of an all-transistor, economical and miniature FM receiver utilizing the active filter technology initiated as a part of the NASA Technology Transfer Program and developed at KIST (vacuum tubes are used for the FM receiver in both Ref. 1 and Ref. 2).

REFERENCES

(1) Weather Satellite Picture Receiving Stations-Inexpensive Construction of Automatic Picture Transmission Ground Equipment, NASA Report SP-5080, by Charles H. Vermillion

(2) Photo Receiver for Weather Satellite Automatic Picture Transmission, a brochure published by EMR Aerospace Sciences

FOR FURTHER INFORMATION

Please contact: S. B. Park
KIST Project Team

INFRARED IMAGE CONVERTER

EE-17

WHAT IS NEEDED

There is a need for design and manufacturing technology of the image converter tube which is an essential part of infrared weapon-sight.

BACKGROUND INFORMATION

Infrared viewing system utilizing near-infrared radiation (spectral range of 0.8 - 1.5μ) was developed by the U.S. Army during World War II and has been used as the night battlefield weapon-sight. The system is the same in principle as the conventional gun-sight except that an image converter is required for converting infrared image into visible light picture.

CONSTRAINTS

The image converter should meet the following requirements:

(1) Sensitive to the near-infrared radiation.

(2) Good image quality.

(3) Compactness and ruggedness.

(4) Light weight.

(5) Simplicity of operation.

POSSIBLE APPROACHES

(1) Photoemissive image converter

Photoemissive surface converts the infrared radiation image into an electron emission, which is accelerated and focused on a phosphor screen to form a visible picture. A high-voltage, low-current power supply is required to operate the tube.

(2) Solid-state image converter (Photoconductor-electroluminescent type)

An electroluminescent phosphor layer and a photo-conductive coating are sandwiched between transparent conducting coatings on two plates of glass. Photoconductive layer becomes conductive when illuminated with radiation, permitting the electric field to appear across the electroluminescent phosphor with a resulting emission of light.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

INDUCTORLESS COMMUNICATION CIRCUITS

EE-18

WHAT IS NEEDED

Design principle and applications of inductorless active filters in various communication circuits in the frequency range of VHF and UHF.

BACKGROUND INFORMATION

Inductors are bulky, heavy, expensive, and difficult to be realized as ideal elements. Elimination of coils and transformers in electronic circuits is therefore highly desirable from the standpoint of economy and, in particular, miniaturization. This has been accomplished to a considerable extent in the low-frequency range but design of active RC filters in the VHF and UHF ranges is a relatively new area of investigation. Since a number of coils and transformers are commonly used in a communication system for the purpose of tuning and impedance matching, elimination of inductors will bring a significant reduction of the

overall size of the system. Mastery of the design and fabrication techniques of inductorless circuits is important in Korean communications circuit development for the following reasons:

(1) The KIST is doing R and D of thick and thin film IC's and the inductorless circuits can be realized in these forms for micro-miniaturization in the near future.

(2) The inductorless circuits can be utilized in the mobile communication systems of 50, 150, and 450 MHz for military and commercial use which will be developed at KIST in 1972.

(3) A great prospect is seen that miniaturized communication systems will be demanded evermore in the international market.

CONSTRAINTS AND SPECIFICATIONS

The inductorless bandpass filter should meet the following requirements:

(1) High gain (over 25 dB) at the desired center frequency in the VHF or UHF range.

(2) High Q (above 100).

(3) Low noise figure (below 3 dB).

(4) Low sensitivity to change of temperature.

(5) Symmetrical frequency response.

(6) Wide dynamic range.

(7) Low sensitivity to change of element values.

FOR FURTHER INFORMATION

Please contact: S. B. Park
KIST Project Team

AN ECONOMICAL RETORT POUCH FOR USE AS A "FLEXIBLE CAN"

FT-1

INTRODUCTION

The cost of tinplate can is very expensive and thus hinders development of the emerging food processing industry in Korea. Since no tinplate is locally produced yet, it is urgent and timely to produce a substitute for the plate, such as a retort pouch, if the substitute does the job of tin cans and can be produced economically.

STATEMENT OF THE PROBLEM

In order to produce more processed food products and for its modernization, the Korean food industry needs convenient and economical containers which can replace tinplate cans. The container should have the following characteristics:

(1) Lower costs than that of tinplate cans.

(2) Resistance against sterilization process in retort and thus free from shrinkage and other damages.

APPLICABLE PRINCIPLES

Such food containers, impervious to long storage and hostile atmospheres, hopefully could also allow faster cooking than tin cans, and thus eliminate the danger of overcooking, browning reaction and breakdown of nutrients. Such containers are convenient for personal carriage for outdoor activities and are simple to dispose of after use.

BACKGROUND INFORMATION

For space foods, NASA has undoubtedly developed several types of flexible packages. Among them "spoon-bowl" packs and "retort pouch" for "wet-pack" meal as a "flexible can" meet the requirements closely. The production cost of the containers, however, may be expensive and not realistic for wider uses in Korea. Thus, special consideration should be given to reducing production cost of the materials.

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

FILTRATION METHODS FOR REMOVING BACTERIA FROM AIR

FT-2

INTRODUCTION

Aerobic submerged fermentation processes require a continuous supply of large quantities of air. However, present filtration systems (fibrous beds of glass wool) to supply sterile air-stream are not good enough for commercial installations. It is necessary, therefore, to improve the methods by which microorganisms can be removed from the air-stream, and to eliminate the risk of contamination.

STATEMENT OF THE PROBLEM

Fermentation industry needs a practical and economical method for removing microorganisms and their spores from supply air.

BACKGROUND INFORMATION

The most satisfactory way to remove the organisms is generally by filtration with absolute filters, whose pores are so small that organisms cannot pass through. However, the operating costs involved for this system make it impractical.

Some microorganism can be removed by the inlet filter, a fibrous bed of glass wool, some may be inactivated in the air compressor, and some can be collected by washing. Even so, large numbers may still be present in the compressed air.

The use of the heat of compression is the way in which high temperature can be considered for air sterilization. However, this method is achieved at the cost of increased power consumption, and has proved to be uneconomical for small installations.

Even with a deep filter there is still some probability of a particle escaping and as the filter depth increases both capital and operating costs are increased. The methods of the electrostatic precipitation and internal radiation are less economic than heating because of the high field intensities required.

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FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

BACTERIOPHAGE MONITORING IN FERMENTATION INDUSTRIES

FT-3

INTRODUCTION

To the fermentation industries employing bacteria, infection of "bacteriophages" often raises serious problems, since the phages destroy bacteria and in turn ruin the fermentation. In order to prevent this disaster, it is highly desirable to establish a system by which the early stages of an invasion of phages can be detected.

STATEMENT OF THE PROBLEM

The fermentation industries need a continuous reading instrument which can record the population of bacteriophages around the fermentation tanks. The monitoring instrument should have the following characteristics:

(1) Sensitive to particle sizes from 50 to 200 μ of biological material. Bacteriophages are biological entities, which will bacteria, consisting of a protein coat and DNA core.

(2) Ability to distinguish the phages from non-biological particles (such as dust).

(3) Disregard biological particles larger in size than the phages, such as bacterial spores, bacteria, yeasts and molds (these are approximately 200 μ and larger).

(4) Ability to detect phage populations as low as 100 particles per 1,000 cm^3.

APPLICABLE PRINCIPLES

A highly sensitive device which can measure the concentrations of specific biomass should be sought. Differences in electronic response between biological and non-biological particles may well be utilized in developing the device. Bioluminescence may also be applicable in this problem.

BACKGROUND INFORMATION

The possible invasion routes of the phages into fermentation tanks are 1) air filter, 2) contamination by other bacteria, 3) agitating shaft of fermenter, and 4) incomplete sterilization of media and instruments.

Currently, the presence of bacteriophages is detected by Soft Agar Test developed by Adams*. In this test, a number of Bouillon Plates inoculated with concerned bacterial culture are exposed to air for 20-30 minutes and incubated at 30°C for 18-20 hours. If the phages are present, plaques will be observed on the plates by the termination of incubation. The numbers of plaques are proportional to the amounts of the phages present. However, this method is cumbersome, time consuming, and requires about 20 hours to obtain results, and thus not practical for routine check-up.

* H. H. Adams: Method in Medical Research, 2, 1 (1950)

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

CONTINUOUS MAINTENANCE OF REDUCED OXYGEN AND CARBON DIOXIDE CONTENTS IN ATMOSPHERE OF WAREHOUSE FOR APPLES

FT-4

INTRODUCTION

In order to minimize spoilage losses of fruits and vegetables during storage, controlled-atmosphere (CA) storage is known to be best. Although

there are methods available for this purpose, the cost of operation is usually very high and thus it is often not practical, particularly in Korea. Therefore, it is highly desirable to establish a new and cheaper method for CA storage.

STATEMENT OF THE PROBLEM

The oxygen content of warehouse atmospheres should be kept between 1.5 and 3% (compared to the normal 21%) which is desirable for maintaining a longer storage life for apples. When apples are kept in gas-tight rooms, the oxygen content is reduced to less that 5% and simultaneously the carbon dioxide level is raised by their own respiration. Since too much carbon dioxide is also harmful, the excess over the level of 5% should be scrubbed. That is, a method is needed to give a controlled atmosphere at 1.5 to 3% oxygen and less than 5% carbon dioxide economically for an extended period of time.

POSSIBLE APPROACHES

For the solution, the following separate technologies may be searched and combined:

(1) Reducing oxygen content and maintaining the level between 1.5 and 3%.

(2) Removing accumulated carbon dioxide from the respiration of apples and maintaining its level at about 5%.

(3) A monitoring system to maintain the above mentioned concentrations of the two gases.

BACKGROUND INFORMATION

Actually CA storage has been around for a long time. Farmers discovered centuries ago that fruits and vegetables can be kept through the winter by putting them in barrels and burying them. Apples themselves control the atmosphere by using up most of the oxygen in the sealed containers. Such a system works, but leaves a lot to be desired. If there are leaks in the warehouse, or if it is necessary to enter the storage rooms, the oxygen content will rise. In order to overcome this difficulty, artificial means of controlling the atmosphere have been developed. For example, nitrogen gas has been used to purge storage rooms, but this is expensive. Inert gas generators, using propane burners to remove oxygen and scrubbers to remove combustion-produced carbon dioxide, have been adapted to CA storage. However, the burners need at least 11% oxygen, so such a system must constantly take in fresh outside air, making it an inefficient process. An improved method of an either

physical or chemical nature should be developed to make CA storage more economical.

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

ALL-PURPOSE SURVIVAL RATIONS

FT-5

WHAT IS NEEDED

Compact and nutritive ration for all purposes.

BACKGROUND INFORMATION

For military activities and even for civil life under certain circumstances, compact ration or survival food is often needed. There are no such products currently available in Korea.

CONSTRAINTS OR SPECIFICATIONS

(1) Compact and light weight.

(2) Nutritionally balanced.

(3) Stable during storage without refrigeration.

(4) Simple to serve.

(5) Convenient to carry.

(6) Acceptable flavor and taste.

(7) No cooking required prior to serving.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

Dehydrated, compressed and fortified foods for astronauts may be useful to the proposed food products.

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

LOW-COST PROCESSES FOR HARVESTING AND DRYING OF MICRO-ALGAE

FT-6

WHAT IS NEEDED

The shortage of protein could be alleviated by new foods from cultivated micro-algae. However, present methods for a large-scale production of micro-algae are not economically feasible. An improved method for harvesting and drying of algae, therefore, needs to be found.

BACKGROUND INFORMATION

Cultivated micro-algae are nutritionally adequate to replace soybean meal in an animal ration but present production cost of micro-algae is far more expensive than that of soybeans. Therefore, harvesting and drying processes of sewage-grown micro-algae, representing more than 40 per cent of the entire production cost, must be modified in order to make the cultivation of algae economically feasible.

With the development of a large-scale method for production of sewage-grown algae, the algae could be economically feasible at a cost competitive with soybean meal. The present methods of harvesting and drying algae are the major impediments to producing algae economically, since they represents over 40 per cent of the entire production cost.

Although centrifugation of algal suspension for harvesting offers the advantages of simplicity and continuity of operation and of the production of material high in quality and devoid of additives, it has certain obvious economical disadvantages. One is the high cost of the contrifuge itself. A second disadvantage lies on the relatively high demand of electric power. A combined method of centrifugation and flocculation by the addition of chemical reagent does not provide simplicity and may have a risk lowering quality of the product due to presence of added reagents. Surface drying or using the sand-bed method appears extremely economical but this is applicable only where sunlight is abundant and largely depends on weather conditions.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

Harvesting of algae is difficult because algae are normally in dilute suspensions and their small physical size precludes simple sedimentation or flocculation. Harvesting and drying the algal crop, therefore, may have to be performed in three major steps: 1) initially concentrating the algal suspension; 2) dewatering and concentrating the resulting slurry; and 3) drying the dewatered algae to moisture content of less than 12 per cent for storage and handling. For the removal of suspended solids and coliform bacteria prior to harvesting the algal crop, absorption or percolation of the contaminant is applicable to the problem.

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

FOOD ADDITIVE TO GENERATE HEAT WITH WATER FOR INSTANT RICE

FT-7

INTRODUCTION

In order to serve pre-cooked or instant rice, heating either by addition of hot water or cooking with cold water is required. However, such treatments are cumbersome and often not practical for outdoor activities. It is necessary to develop a method producing cooked rice simply by addition of cold water.

STATEMENT OF THE PROBLEM

Rice is the staple food in Korea and thus it is highly desirable to develop a true instant rice which can be served simply after adding water. There are several methods of preparing pre-cooked or instant rice, but none gives cooked rice in warm state. A potential food additive generating heat which is sufficient to produce a hot cooked rice from pre-cooked rice even with cold water may do the job. The chemical should have the following characteristics:

(1) Generates heat with water instantaneously.

(2) Not toxic to humans; thus eventually it may be used as a food additive.

(3) Reacts with neither food constituents nor packaging materials such as can, plastics and papers. Thus, no deteriorative changes in nutrients, color, flavor and taste of foods will occur.

(4) Not explosive, but hopefully the reactant may be eliminated as gas.

(5) Preferably lightweight solid material.

APPLICABLE PRINCIPLES

Commercially available instant rice is in dry form with moisture content of about 7 per cent and packed in paper carton. Although addition of water is essential for rehydration of the rice, this process alone does not produce acceptable cooked rice. Even with the presence of water, for example, as in canned rice, it can not be consumed directly. α -starch in cooked rice changes into β -starch, non-digestible form, on cooling. Although it can be assumed that α form of starch in instant rice remains to the same extent after rehydration with cold water, the product is still not acceptable to the Korean palate, because its flavor, mouth feeling, and taste are quite apart from those of immediately cooked rice. Thus, heating is the second important element which makes the instant rice edible as just-cooked rice. However, the problem with outdoor uses of instant rice lies in the addition of heat which is often not practical by conventional means. Thus, if it is available, a potential food additive which meets the requirements described in the statement of problem will play a key role in solving the problem.

In fact, there may be other two approaches by which the heating can be achieved:

(1) Since instant rice can be vacuum packed, heat may be generated by diffusion of air or other gases into the package, if any.

(2) Aerosol system, such as "The Hot One" (a shaving cream from Gillette) which generates heat by pushing aerosol button.

BACKGROUND INFORMATION

This possibility may have not received attention from Western scientists so far, since rice is not an important dietary item in USA and other European countries.

A cooked and dehydrated rice has been produced by a local manufacturer in Korea. Thus, if the desired heat generating system can be found, it will bring a breakthrough in making a "true instant rice product" and will

encourage a new kind of rice processing industry. The technology can also be applied directly to the instant noodle industry in Korea which constitutes about 30 million dollars sales, annually.

FOR FURTHER INFORMATION

Please contact: T. W. Kwon
KIST Project Team

INJECTION NOZZLE USED FOR DIESEL ENGINE

ME-1

STATEMENT OF THE PROBLEM

A small company in Korea manufactures an injection nozzle used in diesel engines. This company has problems in its manufacturing technology from material selection through inspection of the finished product. They would like to increase the product's performance and would therefore welcome pertinent data.

BACKGROUND INFORMATION

This injection nozzle is used for a 120 HP diesel engine which is manufactured by the Hankook Machinery Company who in turn sells their engine to a bus manufacturer in Pusan, Korea.

The problem areas are:

(1) Wear life

The average life of an injection nozzle is about 1,500 hours or the equivalent of about 3 months, after which time it has to be replaced.

(2) Interchangeability

Due to the low precision level of the nozzle (also of the engine itself), ready interchangeability is not attained.

The materials used for the nozzle are imported from Japan and their specifications are: SCM, SCN, SUJ2, SKH.

POSSIBLE APPROACHES

(1) Information on the procedures for making a diesel injection nozzle. This could contain data such as material specifications, dimensional tolerances, machining and grinding information, together with finishing (such as after treatment) and inspection instructions.

(2) Relate the necessary equipment to perform the above specified manufacturing functions.

FOR FURTHER INFORMATION

Please contact: J. W. Nam
KIST Project Team

MAGNETIC INK AND SENSOR

ME-2

WHAT IS NEEDED

A need exists for a magnetic sensor which can be used in conjunction with specially formulated magnetic inks to facilitate the detection of forged cashiers checks. Specifically, the information sought concerns the composition formula of magnetic ink, the design and construction of a relatively simple and inexpensive ink application device adaptable for letter and numerical printing, and a sensing device.

BACKGROUND

Presently, commercial banks and their branches issue cashiers checks in various amounts. These checks are circulated just like currency since the largest denomination of currency issued by the bank of Korea is 500 Won which is equivalent to approximately $1.60. The check does not have to be endorsed until it is returned to the bank for cashing. Therefore, there is no way of knowing who was involved in the circulation process.

There are instances whereby the amount shown in the check is changed from 10,000 Won to 100,000 Won or the entire check is forged.

REQUIREMENTS OF SENSOR

The detection device should not damage the checks being inspected and

must be small enough to be placed underneath the Cashier's desk and also should not take more than a few seconds for detection. The result should be visually indicated.

FOR FURTHER INFORMATION

Please contact: J. W. Nam
KIST Project Team

DIE-CASTING TECHNOLOGY FOR NON-FERROUS MATERIALS

ME-3

WHAT IS NEEDED

A need exists for die-casting techniques involving non-ferrous materials such as zinc and aluminum alloys. There is a particular need for technology applicable to the casting of small objects with intricate contours.

BACKGROUND INFORMATION

Passenger cars are assembled in Korea but major subassemblies, such as engine and transmission, are imported. Government policy requires the auto industry to increase the domestic content through local manufacture of as many components and subassemblies as possible. In order to achieve this the technology of die-casting non-ferrous metals must be developed in order to manufacture such subcomponents as carburetors and starters.

POSSIBLE SOLUTIONS

A large body of non-ferrous die-casting technology resides in the automotive and aerospace industry. It should be possible to tap this vast body of technology.

FOR FURTHER INFORMATION

Please contact: J. W. Nam
KIST Project Team

COMPUTER PROGRAMS FOR MANAGEMENT

ME-4

WHAT IS NEEDED

A list of computer programs and subroutines which may be used in management planning (project management, systems engineering) is needed.

BACKGROUND INFORMATION

NASA has developed and used advanced management programs. Some of these programs and subroutines may certainly be used in the planning sector of Korean industry and government.

FOR FURTHER INFORMATION

Please contact: J. W. Nam
KIST Project Team

SENSOR TECHNOLOGY

ME-5

INTRODUCTION

In various industrial and scientific applications, particularly in advanced technologies such as in automation, servomechanisms, etc., precise control requires sensing and measuring technology of the highest level. In fact, use of sensing devices which surpass human sensory capabilities may be described as the crux of modern technology.

NASA has achieved the highest level of this technology in the guidance and control of rockets and space vehicles, and biomedical monitoring.

In a developing nation such as in Korea, these sensors and what may be described here as sensor technology are not yet realized.

STATEMENT OF THE PROBLEM

All industries require sensors of various types and levels of sophistication, some more precise and others more reliable. The impact of introducing them would be far too broad and varied to list here. The problem areas are indirectly related to general industrial applications.

POSSIBLE APPROACHES

As much as it is not directly related to a specific problem area, the approach is to compile a reference file of written and hardware information classified with respect to precision, use, mode of sensing such as pressure, displacement, acceleration, velocity, etc. and method of sensing such as electromagnetic, inertial, acoustic, etc. Understanding and knowing how to use these sensors, even though it may be difficult as yet to manufacture them in Korea, would sufficiently justify the effort expended in this search.

BACKGROUND INFORMATION

Guidance and sophisticated controls are unknown beyond the level of pre-World War II U.S. technology.

FOR FURTHER INFORMATION

Please contact: J. W. Nam
KIST Project Team

PROCESSING OF TUNGSTEN ORE CONCENTRATES (SCHEELITE) TO TUNGSTEN POWDER

MM-1

INTRODUCTION

Korea has one of the principal scheelite deposits of the world (Sangdong deposit in the Kangwon Province) and presently exports tungsten ores in the form of concentrates. The metallurgical technology of tungsten is required to produce tungsten powder from tungsten ores after ore dressing.

STATEMENT OF THE PROBLEM

The best of the various methods and processes for the treatment of scheelite tungsten ores is sought to produce tungsten powder. The treatment of scheelite tungsten ores required for the production of tungsten powder consists of the following processing:

(1) Decomposition of tungsten ore

(a) With acids, preferably hydrochloric acid

(b) Fusion with sodium carbonate and carbon

(c) By electrolysis.

(2) Purification of tungstic oxide to obtain purities of 99.9% and 99.95%

(a) Precipitation as tungstic acid

(b) Crystallization as ammonium paratungstate.

(3) Production of tungsten powder

(a) Reduction of tungstic oxide or tungstates with hydrogen

(b) Reduction of tungstic oxide, tungstates of tungsten ore with carbon.

The characteristics of tungsten powder to be controlled are the chemical purity, the particle size and size distribution of the powder.

BACKGROUND INFORMATION

The Sangdong deposit in the Kangwon-do of Korea is one of the principal scheelite deposits in the world. The reserve of the deposit is estimated to be 2,280,000 tons averaging 1.7% WO_3. The accessory minerals are molybdenite, bismuthinite, chalcopyrite, fluorite, apatite, quartz and biotite. All tungsten ore mined in Korea is currently exported to the United States in the form of concentrates after ore dressing.

A tungsten mining company desires to carry pre-exportation processing of tungsten ores to the production of tungsten powder. This will increase the value of the exported tungsten and improve Korea's position in export market.

Treatment of tungsten ores for the production of tungsten powder generally involves decomposition of tungsten ores, purification of tungstic oxide and production of tungsten powder. There are various methods and processes proposed for the treatment of tungsten ores. The problem is which of the methods and processes available are best for the production tungsten powder from Korean scheelite tungsten ores. Patents and literature regarding the metallurgy of tungsten are sought.

REFERENCES

(1) Li, K.C. and Wang, C.Y.: Tungsten, Its History, Geology, Ore-Dressing, Metallurgy, Chemistry, Analysis, Applications and

Economics (3rd ed.) Reinhold Publishing Corp., New York (1955).

(2) Smithells, C.J.: Tungsten, Its Metallurgy, Properties and Applications, Chemical Publishing Co., New York (1953)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

INORGANIC COATING OF STEEL FOR FABRICATION OF CHEMICAL REACTION VESSELS

MM-2

INTRODUCTION

High-temperature inorganic-coating technology has been developed for the fabrication of such items as rocket nozzles, heat-resisting shields and bearings. This technology may be utilized for applying inorganic coatings to steel chemical reaction vessels intended for various uses and operating conditions.

STATEMENT OF THE PROBLEM

Techniques of applying inorganic coatings on steel is required so that it can be utilized in the fabrication of chemical reaction vessels that are suitable for use in chemical environments (sulfuric acid, hydrochloric acid, nitric acid, chlorine and dilute alkali solution) at temperatures up to 300°C and pressures up to 400 psi.

BACKGROUND INFORMATION

Stainless steel, Monel, Duriron, Karbate and organic high-polymer lined steel are used as materials for chemical reaction vessels. The selection of material depends on chemical environment (kind and concentration of chemicals), reaction temperature and pressure to which the reaction vessel will be subjected.

In Korea, special alloys (Duriron, Karbate, etc.) are not produced, and also there are no facilities for fabricating such materials. Steel reaction vessels having inorganic coatings are considered for the application in chemical environments at temperatures up to 300°C and

pressures up to 400 psi. The technology relating to coating materials, application techniques and fabrication of coated steel is required.

Coating and fabricating processes that require treating of reaction vessels in big furnaces or ovens are not practical for use in Korea. Possible approaches to avoiding the post-fabrication heat treatment of reaction vessels are the use of flame or plasma spraying of inorganic materials on the completed vessel, and assembly of pre-coated steel plates.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

The technology of inorganic coating of steel should include the following aspects:

(1) Preparation of steel surface.

(2) Specific coating materials.

(3) Methods for applying the inorganic coatings.

(4) Techniques of welding coated steel and remedying cracked (or crazed) areas.

(5) Methods of controlling coating thickness.

REFERENCES

(1) Huminik, J., Jr.: High Temperature Inorganic Coatings, Reinhold Publishing Corp., New York (1963)

(2) Ballard, W.E.: Metal Spraying and the Flame Deposition of Ceramics and Plastics, Griffin, London (1963)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

PRODUCTION TECHNOLOGY OF GRAPHITE ELECTRODES FROM NATURAL GRAPHITE

MM-3

INTRODUCTION

Graphite electrodes for electric-arc furnaces are produced normally from petroleum coke (artificial graphite) and coal-tar pitch binder. Since petroleum coke is not produced in Korea, Korean industrial concerns desire to produce graphite electrodes from naturally occurring graphite (natural graphite) and coal-tar pitch binder. Technical know-how relating to the construction of processing facilities (in particular, baking and graphitization furnaces), the processing of petroleum coke and coal-tar pitch binder, and the processing required to produce good quality graphite electrodes from natural graphite are sought.

STATEMENT OF THE PROBLEM

Korean industrial concerns desire to produce graphite electrodes for electric-arc steel-making furnaces from natural graphite in combination with coal-tar pitch as binder.

The production of good quality graphite electrodes from natural graphite requires the following technical knowledge:

(1) Normal manufacturing practices used to process petroleum coke to artificial graphite electrodes, particularly, graphitization practice (2,800° C) for producing high-strength graphite electrodes and construction of a high-temperature electric furnace for graphitization. The electric graphitization furnace with multi-heat zones is capable of continuous operation in the temperature range of 2,600 to 3,000°C. The normal cycle time for the graphitization process can be 15 to 30 days of which perhaps 2 to 6 days are for heating and the remaining time for cooling.

(2) Treating processes for natural graphite to achieve characteristics to those of petroleum coke -- purity and particle-size distribution.

(3) Modifications of normal processing practices to allow for use of natural graphite instead of petroleum coke as the starting material.

(4) Comparison of economics for producing graphite electrodes from petroleum coke and from natural graphite.

CONSTRAINTS AND SPECIFICATIONS

Artificial graphite electrodes (produced from petroleum coke; cylindrical, 150 to 300 mm in diameter) and natural graphite have properties as shown under a and b, respectively:

	a	b
Apparent density	1.55	1.70
Porosity, %	30	20-25
Bending strength, kg/cm^2	98	70-120
Compression strength, kg/cm^2	225	200-300
Elastic coeff., kg/cm^2	840	900-1,200
Specific resistivity x 10^{-4} Ωcm	9.9	less than 33
Thermal expansion coeff. x $10^{-6}/^{o}C$	1.8	2.1-2.4
Thermal conductivity coeff. kcal/m hr/^{o}C	111	

In addition to the above mentioned properties, high-quality graphite electrodes should be oxidation resistant, resistant to thermal shock, spalling-resistant and suitable for high voltage-high current applications.

APPLICABLE PRINCIPLES

For production of high quality graphite electrodes, the following factors should be considered:

(1) Purity of starting graphite material.

(2) Distribution of graphite particle sizes.

(3) Mixing ratio.

(4) Dimensional design.

(5) Pressing or extrusion conditions.

(6) Heating and cooling rates.

(7) Furnace atmosphere.

(8) Density and porosity of graphite.

BACKGROUND INFORMATION

As Korean chemical and metallurgical industries are growing rapidly, so is the demand for graphite electrodes. Korea imported about 2,700 metric tons of graphite electrodes ($1,314,000 worth) during 1969. The demand is expected to be doubled when Pohang Iron & Steel Company, Ltd. begins operation in 1973.

Korea has large resources of good quality natural graphite but does not produce petroleum coke by cracking crude oil. A few Korean industrial concerns are interested in making technoeconomic feasibility studies for production of graphite electrodes either from natural graphite or from petroleum coke.

Natural graphite that occurs in Korea is mostly amorphous graphite with a fixed carbon content of 75%, and its reserves are estimated to be 70 million tons. There also occurs crystalline graphite with a fixed carbon content of 3% initially and a carbon content of 85% or more after dressing, and its reserves are estimated to be 15 million tons. Korean industries need technical knowledge for domestically producing graphite electrodes either from natural graphite or from petroleum coke.

Once the production technology of graphite electrodes is developed, many important graphite products such as graphite brushes, heating elements, crucibles, refractory bricks can be domestically produced.

REFERENCES

(1) The Industrial Graphite Engineering Handbook. Union Carbide Corp. (1959)

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(3) Othmer, Kert: Encyclopedia of Chemical Technology (Carbon)

(4) Kingswood, V.S.: Carbon in the Engineering and Metallurgical Industries. Metallurgia (Aug. Nov., 1953)

(5) Rodney, H.W., et al.: Graphite Electrodes, Ind. Eng. Chem., 46, 1-11 (1954)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

TANTALUM SOLID ELECTROLYTIC CAPACITORS

MM-4

INTRODUCTION

The tantalum solid electrolytic capacitors have such important advantages as large capacitance per unit volume at a low cost, no need for a hermetic seal, flexibility as to shape, superior temperature characteristics, relatively low power factor and indefinitely long shelf life. Because of these advantages they are more and more used in various electronic equipment requiring good quality, high reliability and long life, namely, in industrial electronics, communication and military equipment. As the Korean electronic industry in growing rapidly, so is the demand for the tantalum solid electrolytic capacitors.

STATEMENT OF THE PROBLEM

Korean industrial concerns desire to produce the tantalum solid electrolytic capacitors for the application in industrial electronics, communication and military equipment. The production of the tantalum solid electrolytic capacitors requires the following technical knowledge and information regarding production equipment and facilities:

(1) Pelletizing and Sintering of Tantalum Powder

The pellet is formed by pressing tantalum powder in a die to shape and sintering at high temperature under vacuum. Prior to pressing tantalum powder is mixed with camphor as a binder and a lubricant. In order to improve homogeneity of camphor distribution, the mixture of camphor and tantalum powder is dissolved in methanol and then the solvent is removed. Optimum green density of pellets, sintering temperature, sintering time and vacuum conditions are the important variables that should be established.

(2) Anodization

A layer of dielectric tantalum oxide is formed on the tantalum surface electrochemically by making the sintered tantalum pellet the anode in an electrolytic bath. The quality and the thickness of the oxide formed that constitutes the dielectric in the ultimate capacitor is controlled by the bath composition, the temperature, the forming voltage and the forming current-time characteristics.

(3) Solid Electrolyte Deposition

The anodized pellets are impregnated with manganese nitrate which is converted to manganese oxide under carefully controlled conditions of time and temperature.

(4) Cathode Application

A layer of graphite and a layer of silver or other conductors are applied sequentially to the pellets that have been treated as above. Consistency of the graphite and the silver solution into which the pellets are dipped has to be controlled.

(5) Encapsulation

After the cathode application the unit is encapsulated with epoxy resin or metal case. Mechanization and control of the dipping or encasement of units into epoxy resin or metal case have to be studied.

(6) Electrical Testing

Test procedures that are to be used in determining and evaluating the voltage rating, capacitance, leakage current, tan δ , frequency and temperature characteristics of tantalum solid electrolytic capacitors have to be established.

(7) Production Equipment and Facilities

The information regarding production equipment and facilities such as the sintering furnace, pelletizer, anodization facilities (rectifier, anodization tank), water treating facilities, and welders are required for either construction or procurement.

BACKGROUND INFORMATION

In Korea the supply of tantalum solid electrolytic capacitors is entirely dependent on imports from abroad. As the Korean electronic industry is growing rapidly, so is the demand for the capacitors, which are important parts for many key electronic products. The potential market is estimated to be one to two million dollars annually. Consequently, the Korean industry needs technology for domestic production of tantalum solid electrolytic capacitors.

REFERENCES

(1) Japanese patent 221,859

(2) McLean, D.A., & Power, F.S.: IRE 44, 872 (1956)

(3) McLean, D.A.: J. Electrochem. Soc. 108, 48 (1961)

(4) Hausner, H.H.: Precision Metal Molding, 15, 44 (1967)

(5) Whitehead, M.: Bell Laboratories Record, 28, 448 (1950)

(6) U.S. Patent 3,100,329

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

FERRIC OXIDE PREPARATION AS MAGNETIC FERRITE POWDER

MM-5

INTRODUCTION

In view of expanding electronic industry in Korea, the demand for ferrites is very rapidly increasing. In order to produce ferrites domestically, its raw material, ferric oxide powder of ferrite grade, must be produced from abundant mill scale or other sources, such as ferrous sulfate which is a by-product of titanium dioxide refining. The technology for economically producing ferric oxide powder of ferrite grade is much needed by the Korean electronic component industry.

STATEMENT OF THE PROBLEM

Magnetic characteristics of a ferrite are greatly affected by its original powder charaxteristics, such as chemical purity, particle size and distribution, particle shape, etc. Therefore, the technology of producing α-ferric oxide power of controlled powder characteristics is in great demand for the Korean industry.

BACKGROUND INFORMATION

The methods presently used for manufacturing high purity α-ferric oxide powder are classified as follows:

(1) Direct calcination of $FeSO_4 \cdot 7H_2O$.

(2) Direct precipitation to obtain Fe_2O_3 (hematite).

(3) Direct precipitation to obtain $Fe_2O_3 \cdot H_2O$ (geollite).

(4) Direct precipitation to obtain Fe_3O_4 (magnetite) and followed by oxidation to obtain Fe_2O_3.

The first method above is the most promising one in view of powder characteristics and economy.

The desired powder characteristics are: 99.5% Fe_2O_3 purity, with spherical particles less than 0.5μ in size.

The most readily obtainable raw materials are mill scale at steel works and ferrous sulphate which is a by-product of titanium dioxide processing.

REFERENCES

(1) Stephens, R.A.: Iron oxides a raw materials for the manufacture of magnetic ferrites, Ceram. Bull., vol. 38, No. 3 (1959)

(2) Mellow, J.W.: Comprehensive treatise on inorganic & theoretical chemistry, vols. XII, XIII, & XIV, Longmans & Green Co., Ltd., London, 1940

(3) U.S. Pat. 1,368,748

(4) Ayars, J.W.: "Black oxides of iron" U.S. Pat. 2,133,267 (1939)

(5) Marsh, D.W.: "Wet-process iron oxide" U.S. Pat. 2,633,407 (1953)

(6) Miller, Paul M.: "Magnetic iron oxide powder from mill scale" U.S. Pat. 2,766,211

(7) Pozin, M.E., & Ginstling, A.M.: "Thermo-chemical conversion of $FeSO_4$" J. Applied Chem., U.S.S.R., vol. 24 (1951)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

SINTERED ALUMINUM POWDER PRODUCTS

MM-6

INTRODUCTION

Sintered aluminum powder (SAP) products are manufactured from flake aluminum powder having a initial oxide content of 1-13%. The flakes are somewhat thicker than 0.01μ, and the oxide films on them are somewhat thinner. Their length is considerably greater. The powder is pressed, sintered and hot worked by extrusion.

SAP alloys can have properties that are superior to conventional aluminum alloys for some high temperature-high strength applications.

STATEMENT OF THE PROBLEM

The production of SAP products requires the following technical knowledge:

(1) Selection of Powder

The flake shape and the oxygen content of powder are important factors affecting the subsequent processes.

(2) Compaction and Sintering

The various compaction and sintering conditions should be studied.

(3) Hot Extrusion

Compacts of aluminum-aluminum oxide powder are by nature porous bodies that require severe hot working to form a dense material with useful properties. Hot extrusion, with its application of high compressive stresses and capability to produce large deformation, is an ideal method for working these materials.

BACKGROUND INFORMATION

Because of their excellent structural stability and the superior mechanical strength above 250°C, SAP alloys are preferable to conventional aluminum alloys for applications at elevated temperatures. In addition, they have a relatively low cross section for capture of thermal neutrons, resistance to irradiation demage, and compatibility with uranium carbide and uranium dioxide. For these reasons, the alloy system is a potential core material in nuclear reactors.

SAP alloys are not produced in Korea. Therefore their development is necessary in the light of their importance in the future.

REFERENCES

(1) Swartzwelder, J. H.: International J. Powder Metallurgy 3 (3), 53 (1967)

(2) Nilsson, T. M.: International J. Powder Metallurgy, 5 (4), 43 (1969)

(3) Gregory, E. and Grant, N. J.: Trans. AIME 200, 247 (1954)

(4) Lenel, F. V., Backensto, A. B., Jr. and Rose, M.V.: Trans. AIME, 203,124 (1957)

(5) Haertlein, J. B. and Sachse, J. F.: Modern Metals, 9 (8), 54 (1953)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
KIST Project Team

EXPLOSIVE METALWORKING OF MILD STEEL

MM-7

INTRODUCTION

Explosive metalworking uses energy from chemical explosions to perform forming and joining, welding and cladding of metals. Some of the advantages of this metalworking method are that it does not require costly tooling (capital investment) and that normally incompatible metals can be welded, joined and clad. Korean industrial concerns desire to utilize explosive metalworking to form mild steel and to clad mild steel with dissimilar metals.

STATEMENT OF THE PROBLEM

(1) Korean industrial concerns need to know specific conditions for explosive forming of mild steel into a dome shape:

(a) Types of explosives

(b) Amount of explosive charges

(c) Explosive forming die material

(d) Lubricants

(e) Energy transmission medium

(f) Low-cost explosive-forming facility

(g) Safety rules.

(2) They need to know specific conditions for explosive bonding (cladding or welding) of mild steel with stainless steel, titanium, aluminum alloys and Inconel:

(a) Types of explosives

(b) Amount of explosive charges

(c) Stand-off distance

(d) Material combinations

(e) Preparation of metal surfaces to be bonded

(f) Safety rules.

BACKGROUND INFORMATION

Korean metal fabricators do not have big presses to form metals to make large storage tanks and pressure vessel domes. They usually have fabrication orders for a variety of shapes but only in small quantity. They are interested in applying explosive forming techniques to form 0.1-inch thick (maximum) and 3 foot diameter mild steel plates into dome shapes.

Big rolling mills that can be used for sandwich (cladding) rolling are not available in Korea. They are interested in cladding by explosive bonding (welding) 0.1 inch thick mild steel (3 feet by 6 feet) with Type 304 and 316 stainless steel, titanium, aluminum alloys and Inconel. The clad steel plates are intended for use in the fabrication of chemical reaction tanks.

REFERENCES

A computerized search of the aerospace literature and the DMIC literature has been made. A number of related references have already been identified and some of them are listed below. However, some relevant technology might not be identified by this means and any additional references and comments you offer would be appreciated.

(1) High-Velocity Metalworking-A Survey, NASA Technology Utilization Survey, NASA SP-5062

(2) Explosive Forming of Metals, DMIC Report 203, Battelle Memorial Institute, Columbus, Ohio (May 8, 1964)

(3) Explosive Bonding, DMIC Memorandum 225, Battelle Memorial Institute, Columbus, Ohio (Sept. 15, 1967)

FOR FURTHER INFORMATION

Please contact: Y. K. Yoon
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APPENDIX F

ADDITIONAL PROBLEM STATEMENTS

Statements of the 14 additional problems defined during Phase V are presented in this appendix.

DESIGN PRINCIPLES OF ACTIVE BAND-PASS FILTERS FOR HIGH FREQUENCIES

P-1

WHAT IS NEEDED

Design principles of practical, low-sensitivity, narrow-band and wide-band active RC filters for frequencies above 100 KHz.

BACKGROUND INFORMATION

Inductors and transformers are bulky, heavy, expensive and hard to realize as ideal circuit elements. Therefore, elimination of inductros and transformers is essential in the achievement of ultimate microminiaturization of electronic circuits. This requirement has resulted in the development of the so-called active RC filters. A number of synthesis methods for active RC filters have been published in the past 15 years (1), but most of them rely on the existence of certain ideal basic active units. However, this assumption is invalidated by present technology in the higher frequency region. In addition, most active RC networks are highly sensitive to changes in circuit parameters. Therefore, the need of developing design principles of practical, low-sensitivity, inductorless band-pass filters usable in the frequency region above 100 KHz (and hopefully up to VHF) is the most urgent requirement in any attempt at integrating electronic circuits operating in this frequency range.

CONSTRAINTS AND SPECIFICATIONS

The active RC band-pass filters needed should meet the following requirements:

(1) The design principles should be applicable to any frequency region above 100 KHz and hopefully up to 500 MHz.

(2) Sensitivities of Q and the center frequency with respect to the changes of circuit parameters (in particular, active parameters) should as low as possible, say below 10^{-2}.

(3) In case of narrow-band filters, Q must be greater than 50.

(4) In case of wide-band filters, Q must be greater than 20.

(5) Power gain must be greater than 20 dB.

(6) If any controlled source is used in the design, detailed information on its design is desirable.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

Conventional basic active units such as operational amplifiers, gyators or NIC may not be used in the frequency region under consideration, although some types of controlled sources with low gain may be used up to a few MHz. It is quite possible that the design principles must take into account high frequency effects of the transistor.

REFERENCE

Newcomb, N.W.: Active Integrated Circuit Synthesis Prentice-Hall, Inc. (1968)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
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AGRICULTURAL USE OF BLAST-FURNACE SLAG AS FERTILIZER OR SOIL CONDITIONER

P-2

WHAT IS NEEDED

Technology of blast-furnace slag utilization for agricultural purpose.

BACKGROUND INFORMATION

It is generally known that 80% of blast-furnace slag output is used for slag cements, agricultural slag, building blocks, concrete units, ceramic ware, and so forth, and that the rest 20% is wasted in the United States of America and Japan.

Within a few years Korea is expected to have available large amounts of blast-furnace slag from the newly built works of the Pohang Iron & Steel Co., Ltd. The profitable utilization of slags (blast-furnace slag in the main) can have a decided effect on production costs of iron and steel. Lean ores naturally produce much more slag than do rich ores, and a good slag economy consequently has an even greater effect in works where this type of ore is smelted.

If slag cannot be profitably utilized at any particular moment, and

must be placed on a dump, no credit balance is forthcoming and additional transport costs per ton of pig iron have to be met. Therefore developing commercial uses of blast-furnace slag will be one of the most urgent problems facing Korea. Among the non-metallurgical uses of blast-furnace slags, utilization for fertilizer and soil conditioner is practically preferable in Korea. However, the technology of slag utilization for agricultural purposes has not been introduced here in detail.

CONSTRAINTS AND SPECIFICATIONS

The chief food elements that plant life or vegetation obtain from the soil are potassium, phosphorus and nitrogen, but other chemical elements such as iron, sulphur, and manganese are essential. For plants to thrive, soil conditions must be favorable, particularly with respect to humus content and basicity. Thus, if the soil is in clods or acid, unsatisfactory crop results are obtained, irrespective of the amount of fertilizer applied.

Blast-furnace slag contains many of the mineral elements necessary for plant growth, notably manganese, boron, sulphur, and iron. It is known that an important function of slags is to correct such adverse conditions as those mentioned above.

Thus, practical techniques for manufacturing slags suitable for the following agricultural purposes are desired:

(1) Reduction of soil acidity.

(2) Alteration and improvement of physical characteristics of soils.

(3) Supply of essential plant nutrients lacking in many soils.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING PROCESS OF COPPER-

SLEEVED ALUMINIUM WIRE

P-3

WHAT IS NEEDED

Aluminum wire sleeved with copper for electrical transmission lines.

BACKGROUND INFORMATION

Due to its good electric conductivity, copper has long been used as electrical wire and cable. Recently, the price of copper has increased tremendously in the domestic market. The current price of copper is 460,000 Won/ton (equivalent to 1,243$/ton). This ever-increasing market price makes it necessary to find a new material to replace the copper in electrical cable.

Aluminum wire might be considered because aluminum is not only cheapter than copper in the domestic market (235,500 Won/ton equivalent to 700$/ton), but it is also easily workable. However, aluminum has an unacceptably higher electrical resistivity (2.75 micro-ohm. cm compared to 1.673 micro-ohm. cm for copper).

A possible solution to this impasse might be aluminum wire sleeved or coated with copper, if the electrical and mechanical properties were comparable.

CONSTRAINTS AND SPECIFICATIONS

The aluminum wire sleeved with copper should meet the following requirements:

(1) The workability (drawing) of copper-sleeved aluminum wire should be as good as that of copper wire in the mass production.

(2) The electric conductivity, tensile strength and elongation should be just as good as or better than for copper wire.

(3) The gap between two metals due to differential thermal expansion should be minimized.

(4) The elongation difference between the aluminum core and the copper sleeve should be minimized.

CHARACTERISTICS OF RELEVANT TECHNOLOGY

The technology of coating or sleeving aluminum with copper is required. Information on the separation of aluminum from copper by resmelting also should be sought.

REFERENCE

Al-Cu Rod by Texas Instrument Co. Attelboro, Mass.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

DESIGN TECHNIQUE FOR

50 MHz FM TRANSCEIVER

P-4

BACKGROUND INFORMATION

KIST is pursuing development of a portable 50 MHz FM transceiver which 1) uses a whip antenna, 2) has improved sensitivity, 3) has improved noise figure.

So far we have worked out a prototype which has the following performance characteristics:

(1) Maximum available power at transmitter output amplifier of about 2 watts.

(2) Minimum detectable signal voltage of 1 microvolt at the input port of the 1st RF amplifier of the receiver.

(3) Overall gain of the receiver is 120 dB.

(4) Noise figure of the receiver is 5 dB.

INFORMATION REQUIRED

We would like to obtain the following technologies:

(1) Design technique for whip antenna matching device including technical data.

(2) Design technique for super sensitive receiver front end (detectable signal voltage as low as 0.1μ V at 50 MHz).

(3) Schemes to suppress spurious signals generated in synthesizer-mixer.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

RADIATION EFFICIENCY IMPROVEMENT OF WHIP ANTENNA

P-5

WHAT IS NEEDED

Improvement of radiation efficiency for the whip antenna used in the portable transceiver.

BACKGROUND INFORMATION

In any radio communication system, the antenna is an important device. A portable transceiver has so many restrictions, such as output power, component size, and whip antenna length (VHF), that the antenna system assumes even greater importance. In measuring the radiation impedance of a whip antenna which has a small ground plane, the grounding effect introduced by connecting the test instruments affects the antenna characteristics. In order to match the transmitter to the antenna, a designer must know the correct impedance of the whip antenna.

CONSTRAINTS AND SPECIFICATIONS

Freq. Range: V.H.F.

Transmitter output impedance: 50 ohm

Transceiver Cabinet: Metal or Plastic

Antenna length: Shorter than $\frac{1}{4}$ wave length

INFORMATION REQUIRED

(1) Method of measuring the whip antenna impedance under operating conditions.

(2) Recommended test instruments.

(3) Special considerations for achieving corrent and accurate measurements.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

CERAMIC COATING FOR METAL

P-6

INTRODUCTION

Superior corrosion resistance of ceramic-coated metals is devalued in practice by their inferior ruggedness under mechanical shock and vibration and thermal shock. If the problems concerning metal-ceramic coating technique, and development of ceramic coating materials with thermal expansion coefficients similar to those of matrix metals are solved, Korea will be able to reduce its imports of these materials which are used in the chemical, metallurgical, and machinery industries.

The technology of metal-ceramic coating developed for rocket nozzles, heat-resisting shields and bearings has been applied in the production of porcelain enamel, household utensils, burners, chemical reaction tanks and pipes, internal combustion engine components, and electronic components.

STATEMENT OF THE PROBLEM

Glazed mild steel and thermal resisting steel are manufactured by the fritted method while oxide-coated metal products are produced by the thermo spray gun and rocket methods. Products made by the fritted method should be able to resist oxidation up to 600°C for mild steel and up to 900-1000°C for thermal resisting steel. Oxide-coated metal products should be applicable for electronic components and for sealing components which operate under corrosive atmosphere at high temperature. Therefore, the products must be have the following characteristics: high thermal shock

resistivity, hardness, corrosion resistivity, mechanical flexture strength, and good electric insulation properties.

INFORMATION REQUIRED

(1) Manufacturing processes and optimum conditions for producing glazed mild steel by the fritted method.

(2) Manufacturing processes and optimum conditions for producing oxide-coated metal products by the thermo spray gun and rocket methods.

(3) Information on the design and operation of the thermo spray gun and rocket.

(4) Data on the various characteristics of the metal-ceramic coating materials, such as:

(a) Thermal expansion coefficient differences between matrix and coating materials.

(b) Surface conditions of matrix metals to be coated

(c) Viscosity of coating materials at elevated temperature

(d) The cooling rate of ceramic coated metals

(e) Pin holes in coated layer

(f) Disturbance by shrinkage

(g) Oxidation of metal surface to be coated

(h) Gas solubilities of matrix metals due to temperature variations

(i) Chemical reactions of coating materials between various acid and alkali solutions due to temperature variations

(j) Electro-chemical reactions of coating materials placed between charged substances.

BACKGROUND INFORMATION

(1) Ceramic coating for corrosion resistance

For anti-corrosion linings, the ceramic layer should have a

constant thickness in the range from several hundred microns to several millimeters. Thicker layers do not enhance the anti-corrosion properties, but cause weakness to thermal shock.

(2) Ceramic coating for abrasion resistance

Abrasion resistant layers are required to have a hardness greater than 8 on Mohr's scale.

(3) Barrier to advancement of current production technology

Ceramic-coated metals which have been produced are mostly unstable to any kind of physical violations. This problem may be solved by increasing the bonding affinity between the metal surface and the coating ceramic.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

TECHNOLOGY FOR SOLID-WASTE TREATMENT

P-7

INTRODUCTION

The increasing problem of solid-waste as one of major pollutants of the environment has threatened human life everywhere. To cite a case, inefficient incineration, burning dumps, the effects of dumps and landfills affect the qualities of air and water.

It is evident that proper management of solid waste is a key to solving some environmental problems.

In this regard, the technology for the treating solid waste of various types can be applied to problems in every country.

STATEMENT OF THE PROBLEM

Treatment technology for solid waste, including

residential waste

commercial and institutional waste

industrial waste

mineral waste

agricultural waste.

INFORMATION REQUIRED

(1) Impact and influence of solid waste on environmental quality.

(2) Inter-relationship of solid waste and other environmental pollutants.

(3) Collection method
(4) Disposal techniques
(5) Sorting and separation
(6) Reuse and recycle
(7) Other related information (Legislation, economics, etc.)

} For various solid wastes.

BACKGROUND INFORMATION

Solid waste covers a wide range of different materials (metal, paper, plastics, organic and inorganic waste, etc.). In view of this wide range, the treatment technology should also be diverse to meet specific problems, e.g.:

(1) Incineration for urban solid waste.

(2) Shredding for metal waste.

(3) Landfilling.

(4) Dust collecting.

This technical information should cover a broad span of sources from engineering to economics.

REFERENCE

* Environmental quality

First and Second Annual Report of the Council on

Environmental Quality, U.S.A., Aug. 1970/Aug. 1971.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING TECHNOLOGY OF SELF-LUBRICATING STEEL BEARING BY SQUEEZE-CASTING METHOD

P-8

INTRODUCTION

Squeeze casting is called variously extrusion casting, or liquid-metal forging, or pressure casting. It is generally known that forgings have high equipment and die costs compared to castings of the same shape and material, but castings do not have the same superior mechanical properties. By means of squeeze casting, it is possible to cast parts with forged quality. The advantages of this process are the lower power consumption, the shorter cycle times, the elimination of flash waste, and the high lead content of the products (up to 15 per cent).

STATEMENT OF THE PROBLEM

(1) Metering molten metal into a female die cavity.

(2) Pressure distribution at the moment of solidification.

(3) Die design or metal temperature control for degassing.

(4) Release agent for mold or die casting.

INFORMATION REQUIRED

(1) Pb-alloy steel components for making self-lubricating bearings by squeeze casting process.

(2) Experimental data of squeeze-casting process to make self-lubricating bearing.

(3) Techniques for control of various processing parameters in the squeeze-casting operation, including:

(a) Die temperature.

(b) Metal temperature.

(c) Metal volume.

(d) Mole or die coating.

(e) Time delay for application of pressure.

(f) Pressure application time.

(g) Squeeze pressure level.

(h) Pressure speed.

(i) Removal of casting.

(j) Die materials.

(k) Die design method.

BACKGROUND INFORMATION

Lead plays an important role in self-lubricating bearing, and squeeze casting may be used on alloys with a lead content as high as 15 percent. (1)

REFERENCE

(1) Wakefield, B.D. "Squeeze casting has U.S. Friends", Iron Age, pp. 99 (May 28, 1970)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

STABILIZATION TECHNIQUES OF SOLID-STATE MICROWAVE SOURCES

P-9

INTRODUCTION

Presently enormous efforts are being made throughout the world to replace the conventional microwave sources such as klystrons and magnetrons with solid-state sources, i.e., Gunn or avalanche diodes. These solid-state devices are invariantly unstable, thus they are usually coupled to temperature-stable and high-Q resonators. Though some literature is available on source stabilization, it is rather sketchy, and does not give details for actual design.

STATEMENT OF PROBLEM

Gunn and avalanche diodes of X-Band or Ku-Band require frequency- and power-stabilization. The diode will be incorporated in a brass cavity, which will be coupled to a temperature-stable cavity. Or as an alternative the diode will be mounted on a microwave integrated circuit, and the circuit will be temperature-compensated by a computer-aided design technique.

INFORMATION REQUIRED

(1) Temperature-compensation techniques for a brass or invar microwave cavity.

(2) Stability analysis and design details for cavity-backed solid-state microwave sources.

(3) Stability analysis and design details for microwave diode sources built by the microstrip-line technique.

(4) Noise analysis and measurement techniques for solid-state microwave sources.

BACKGROUND INFORMATION

For a temperature-stable microwave cavity, a ceramic cavity may be cited. However, Korean industry does not possess the capability of machining glass-material. Frequency stability of $10^{-6}/^{\circ}C$ is sought, and no information is presently available as to the best stability obtainable from metal microwave cavities. The power which the diodes will deliver will be in the range of 0.2-2 watts.

REFERENCE

(1) Gunderson, L.C.: "Temperature Dependence of Composite Coaxial Resonaters", IRE Trans. Vol. MTT-15, No. 2 pp. 124-127 (February 1967)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

ANALYSIS OF RADIATION CHARACTERISTICS FOR PHASED-ARRAY ANTENNAS

P-10

INTRODUCTION

There are many different types of electronic scanning antennas, namely the phase-scanned antenna, frequency-scanned antenna, and the "Luneberg Lens" antenna where the signal is switched sequentially to each of the multiple-feed waveguides. For reasons of simplicity and economy, the circular or slot planar aperture, X-Band phase-scanned antenna is being considered for search and tracking purposes, and probably the method of space feed will be employed. The beam-width of the antenna will be 2-3 degrees and the scan range, $\pm$45 degrees. The gain of the antenna is desired to be more than 30dB.

STATEMENT OF PROBLEM

Radiation pattern of the planar aperture phased-array antenna must be determined at various scan angles, considering array factor and element factor. This computation will be fairly complex and is expected to require considerable amount of computer work. Design and fabrication of either ferrite or diode-phase shifters will be carried out. Impedance matching of the antenna over the entire scan angle should be done both theoretically and experimentally.

INFORMATION REQUIRED

(1) Computation technique of radiation pattern and polarization for either circular or slot planar aperture, X-Band phased-array antenna at various scan angles.

(2) Design of phase shifters for space feed, X-Band phased-array antenna for the scan range of $\pm$45 degrees.

(3) Impedance matching technique for the wide range of scan angle.

BACKGROUND INFORMATION

According to "Microwaves", June, 1970, Vol. 9, No. 6, p. 53, it appears that the computer program to compute the radiation characteristics of phased-array antenna for most types of radiators has become available. However, most of the references concerning phased-array (or Electronic Scanning) antennas have been found to be unobtainable. A practical design report for a small scale phased-array antenna with no more than 1500 radiating elements would be very useful for the future antenna project at KIST.

REFERENCES

(1) Hardeman, Lyman J. "Phased-Arrays Scan Rapidly Towards Growth in the 70's", Microwaves, pp. 38-54 (June, 1970)

(2) Special Issue on Electronic Scanning, Proc. of the IEEE, (Nov. 1968)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

EXPLOSIVE CLADDING OF LEAD PLATE TO STEEL PLATE

P-11

INTRODUCTION

Since most metals for special use are costly, it is desirable to use composite metals in view of economy. Explosive cladding is one of the methods of producing the composite metal. Lead with a boiling point of 1620°C could hardly be fusion welded to steel with a melting point of 1500°C. Hence it is reasonable to consider the adoption of explosive method which uses energy from the detonation of chemical explosives.

WHAT IS NEEDED

The process of explosive cladding of lead plate to steel plate.

BACKGROUND INFORMATION

Explosives are normally associated with war, but their application to the metalworking field has remarkably increased since the last war. Their large latent energy, low cost, and other characteristics have prompted the development of explosive metalworking, and many explosive-clad metals have been produced on commercial scale.

Lead-steel composite metals are needed for acid vessels, but the conventional production method, which spills molten lead on steel plate, requires several steps, such as pretreatment and melting process, etc. Moreover the bond between two metals is prone to break. Hence the explosive cladding method is considered a desirable one.

INFORMATION REQUIRED

(1) The bond strength and other mechanical and metallurgical properties.

(2) The explosive specifications, such as kinds, composition, density, detonation velocity, and energy, etc.

(3) The relation between process variables, such as explosive loading quantity, standoff distance, cladding plate (lead) and base plate (steel) thickness, etc.

(4) The method to protect the base plate (steel) from shock waves.

(5) The equipment and accessories specifications.

REFERENCE

Crossland, B. and Williams, J.D.: "Explosive Welding", Metals and Materials, Review 144 (July 1970)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

MANUFACTURING TECHNOLOGY OF A NEW SHEET MATERIAL FOR USE AS THE FLOORING OF KOREAN ONDOL ROOM

P-12

WHAT IS NEEDED

The manufacturing technology of

(1) A new sheet material suitable for use as the flooring of Korean Ondol rooms, and

(2) An adhesive that could effectively bind this sheet material to the cement layer which forms the floor of the Ondol room.

BACKGROUND INFORMATION

Most homes in Korea have an Ondol room. This is the traditional "living room" of the Korean house, where shoes are not worn. The identifying characteristic of the Ondol room is its heated floor.

The structure of a modern Ondol room is shown in Figure 1. The floor is a raised cement slab which rests on a number of parallel concrete block barriers. The fuel, an anthracite briquette, is burned in the fuel hole and the combustion gasses pass through the tunnel-like flues, heating the cement layer, on their way to the chimney. The flooring material, the so-called "floor paper board", is attached to the cement layer with paste.

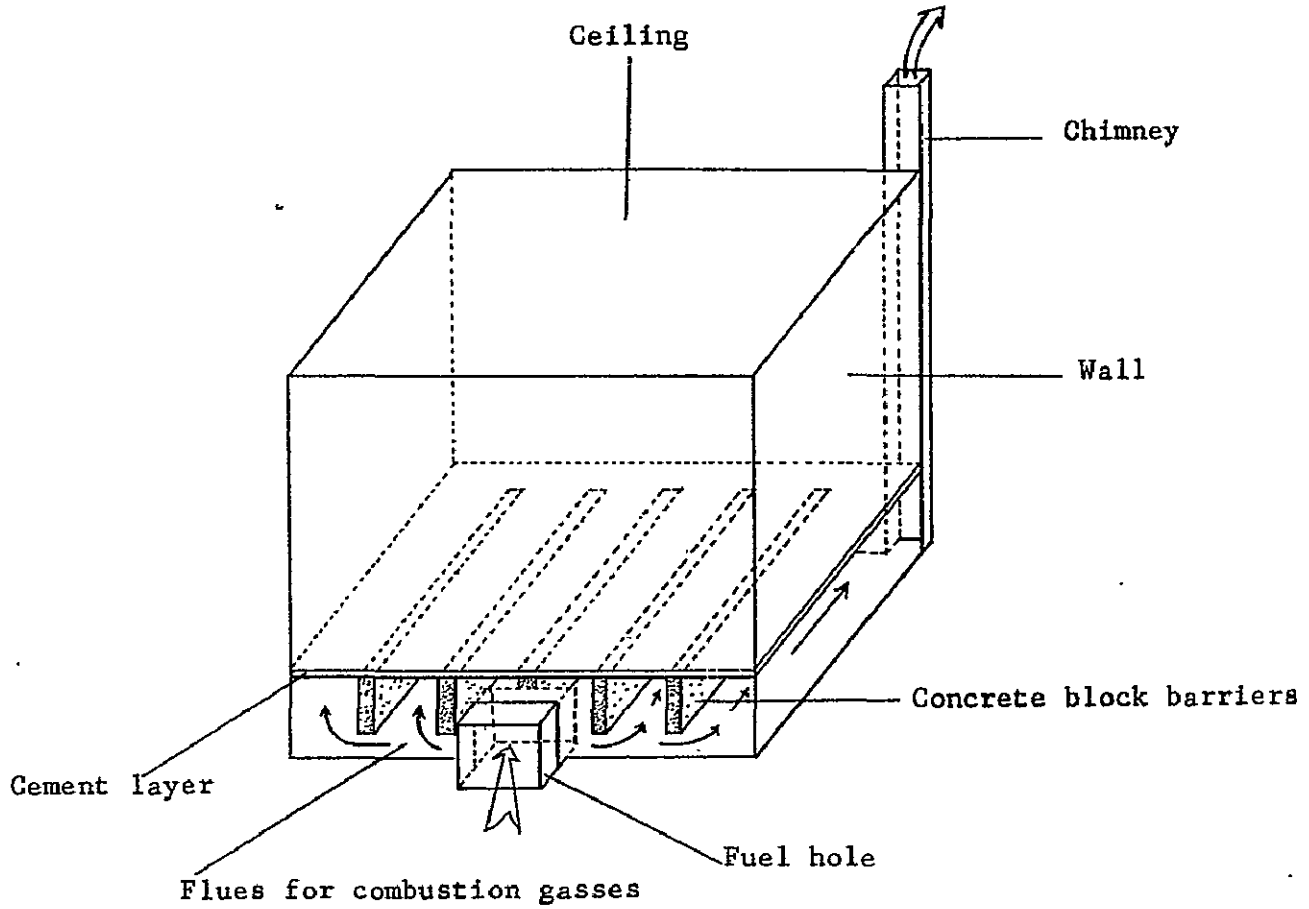
The traditional floor paper board is made of layers of Korean rice paper impregnated with linseed or cotton seed oil. This material has considerable moisture permeability, but certain disadvantages exist. These include:

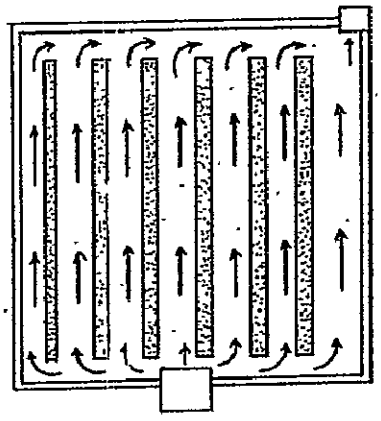
(1) Poor wear-and-tear resistance.

(2) Easy rotting on prolonged contact with moisture. (A considerable amount of moisture usually accumulates in the colder sections of the Ondol floor.)

(3) Slight heat resistance, so the paper is easily burned through by overheating of the floor bed.

Recently, artificial materials, such as plastic sheets of polyvinyl chloride, have begun to replace the traditional Korean papers as a flooring for the Ondol room. However, in spite of their superior durability and convenience, they cannot compete with the oil-impregnated paper flooring





(Plan view of Ondol flues and flow of combustion gasses)

Figure 1. The Structure of Ondol Room.

because of the following disadvantages:

(1) Tendency to deform at high temperatures.

(2) Tendency to become stiff and hard in cold weather.

(3) Lack of moisture permeability or water absorbancy, so that condensation accumulates between the plastic sheet and the cement layer.

The physical properties of the sheet materials used as floorings for Ondol rooms in Korea are shown in Table 1. The price and annual consumption of each product is given in Table 2.

Therefore, it is quite desirable to develop a new sheet material and adhesive which could be used for the flooring of Korean Ondol room.

The desired sheet material should have a good moisture or water-vapor permeability and should be resistive to heat, flame, moisture, impact, and abrasion. Its surface should be smooth and glossy, resistive to shear, tear, impact and staining, and possess good printing characteristics. Finally, the material should not stiffen in cold weather and its surface feeling should be warm like that of natural leather.

The adhesive also should be moisture permeable, heat and moisture resistive.

So far the following two experiments have been performed:

(1) Coated synthetic paper

A synthetic paper was made from a mixture of wood pulp and synthetic paper (preferable polypropylene) and coated with varnish. The prepared paper sheet possessed good moisture permeability, but with the top coating, the permeability vanished.

(2) Coated asbestos paper

An asbestos paper was coated with a varnish. The material was not moisture permeable.

CONSTRAINTS AND SPECIFICATIONS

The new sheet material should meet the following requirements:

TABLE 1. Physical Properties of Vinyl Sheet and Traditional Korean Paper

	Standards	Vinyl Sheet	Traditional Korean Paper	Remarks
Moisture permeability		Not tested	Not tested	
Water absorption	ASTM D1505-63T D570-63	Negligible	40%	By weight, 24 hrs. at 20°C
Tensile strength	ASTM D882-61T	148 Kg/cm^2	316 Kg/cm^2	At room temp. (78°F)
Heat resistance	ASTM D759-48	Temp. Tensile Strength 170°F 38 Kg/cm^2 140°F 65 " 122°F 84 " 90°F 108 " 78°F 148 "	Not tested	No testing Standards for Korean traditional papers
Elongation	ASTM D882-64T	211%	Not tested	"
Specific gravity	ASTM D1505D-63T D570-63	1.61	0.95	
Thickness		0.8 mm	0.5 mm	

TABLE 2. The Consumption and Prices of the Sheet Materials (1971)

Sheet Materials	Annual Consumption	Size	Price
Vinyl Sheets	12 million sheets	3.3' x 4' x 0.03"	80¢ per sheet
Traditional Korean Paper	12 million sheets or more*	"	55¢ per sheet

* The exact consumption of the traditional Korean papers is not known.

(1) Moisture permeability

Above 3 $mg/cm^2/hr/0.5$ mm thickness.
(Superior or equal at least to the moisture permeability of Corfam, the artificial leather developed by DuPont Co. in U.S.A.)

(2) Water absorption

Between 7-10% by weight when immersed in water 24 hours.
(Equal to the water absorption of good quality hardboards.)

(3) Heat resistance
Flame resistance
Elongation
Tensile strength
Tearing strength
Folding endurance

} Superior or equal at least to those of the present vinyl sheet material.

(4) Price

Lower than 80¢ per a sheet of size 3.3' x 4' x 0.03".

(5) Specific gravity Less than 1.6.

(6) Thickness

Between 0.6 - 1.0 mm.

REMARKS

Because of a lack in proper testing apparatus we could not determine important properties of the sample sheet materials such as moisture permeability, flame resistance, and folding endurance.

We hope the untested properties of the materials could be tested in NASA's laboratory and the characteristics given in Table 1 could also be retested for verification. We have enclosed sufficient sample materials for the testing in the attached package.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

DESIGN PRINCIPLES OF IMPROVED IGNITION SYSTEM FOR AUTOMOBILE GASOLINE ENGINES

P-13

WHAT IS NEEDED

Detailed design principles of automobile ignition systems with improved performance over conventional systems.

BACKGROUND INFORMATION

With a view toward improving the performance of automobile ignition systems, a number of manufacturers have announced new ignition systems in the past decade. These fall into two general categories, transistor ignition systems and capacitor-discharge systems. Although the advantages of these new systems are well-known, no automobiles in Korea use them at the present time. This may be attributable to the necessity of considerable modification of the conventional system and the rather high initial installation cost.

In order to contribute to the reduction of air pollution (which is a serious problem in this country, too), and to improve of fuel consumption, it is thus necessary to develop some new ignition system which is reasonable in cost, does not require extensive modification of the existing system, and yet has performance comparable with presently available transistor or capacitor-discharge systems. The difficulty in starting the investigation in this direction is that few makers have published the design principles of new systems in any useful detail. Thus, it is necessary, initially, to collect all available information on the design principles and performance of any improved ignition system.

INFORMATION REQUIRED

(1) Design principles of all improved ignition systems.

(2) Performance data for the various existing ignition systems.

CONSTRAINTS AND SPECIFICATIONS

The new ignition system should have the following characteristics:

(1) Ignition-coil secondary voltage should be around 15 KV-20 KV and fairly constant (within $\pm 10\%$) over the entire range.

(2) Ignition-coil primary average current should be less than 4

amperes and fairly constant (within ±10%) over the entire range and temperature range (0°F-110°F).

(3) It should not require much modification of the conventional system except coil redesign, addition of transistor circuits, and the like.

(4) Elimination of contact points is desirable but not necessary provided the new system assures a prolonged life of contact points.

(5) The production cost should not exceed $10.

REFERENCES

(1) Crouse, W.H.: Automotive Electrical Equipment, McGraw-Hill Book Co., 1966.

(2) Norris, J. : Delcotronic Transistor-Controlled Magnetic Pulse-Type Ignition System, SAE Paper 617B.

(3) Whitaker, S.D.: The spark plug and the influence of its condition as the ignition of combustion, Advances in Automobile Engineering Part IV, Pergamon Press (1966)

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

LIFE-TESTING METHOD FOR DEEP-GROOVED BALL BEARINGS

P-14

INTRODUCTION

The accurate prediction of bearing lifetime is essential to secure the reliable and efficient running of industrial equipment in which bearings are utilized.

In Korea, several million bearings are manufactured and used each year. However, the exact method of lifetime testing for bearings is unknown here. Therefore, uncertainty in the lifetime of the bearings retards development of the bearing industry and many others.

STATEMENT OF THE PROBLEM

Life-testing method for deep-grooved ball bearings of SAE 52100 standard type.

INFORMATION REQUIRED

Information on rolling-fatigue testing to evaluate actual basic dynamic load rating of SAE 52100 204 size standard ball bearings:

(1) Theory of testing.

(2) Requirements of testing.

(3) Design of testing equipment.

(4) Statistical treatment of the results of the experiments.

(5) Any relevant data for this testing.

FOR FURTHER INFORMATION

Please contact: K. H. Hyun
KIST Project Team

APPENDIX G

REPORTS ON INTENSIVE FOLLOW-UP PROBLEMS

The results of applications engineering and current status of implementation for each of the problems selected for intensive follow-up and immediate transfer are reported in this appendix.

EE-1 MINIATURE TRANSCEIVERS FOR PERSONAL RADIOS

The following report was prepared by Dr. Man Yung Chung, the KIST staff member responsible for transfer activities pertaining to this project.

PROBLEM STATEMENT

There are three subproblems under the title:

a. Citizens-Band Transceiver

49-MHz AM transceivers are allowed to use for home and industrial purposes in Korea. The Han-Jin Electronics Company in Korea has a contract with KIST for research and development of citizens band transceivers. The NASA technology has been extensively utilized in the development.

b. Pocket Bell Systems

Wireless bell type systems are being developed. One of the type is a two-way tone signal system. The miniature electronics technology of the NASA helped much in this technical area.

c. Military Transceivers

This is the development of transceivers for the Korean Armed Forces. The transceivers are for squad and platoon level communications.

ARAC SEARCH RESULTS

For the EE-1 technology transfer, 49 microfiches and 19 hard copies of technical papers were obtained through ARAC. Among them the following papers supplied substantial technological information:

(1) Fletcher, K.L.: "The new look in avionics equipment" N67-23984

(2) Zimmer, Carl R.: "Frequency modulation systems for space application" A67-38234

(3) Brown, J.S.: "Microminaturization of an integral sensor telemetry transmitter" A67-25272

(4) Carter, H.G. and Rachal, F.: "Molecular helmet transceiver" A67-17466

(5) Tewksbury, John M.: "An airborne VHF transceiver without moving parts" A64-18294

(6) "Navigation/Communications equipment" A64-27755.

JUSTIFICATION FOR SELECTION AS INTENSIVE FOLLOW-UP PROBLEM

The technologies of receiver circuits using monolithic IC's and hybrid IC's are needed for existing Bell Boy System (FM), miniaturized citizens band transceivers (AM), and military transceivers in Korea.

Bell Boys are used as FM receivers with selective calling devices. If smaller monolithic FM receiver circuits are used for this system, the receiver will be utilized for a popular mobile telephone.

The citizens-band communications use AM systems at 27 MHz. Using VVC diodes instead of an usual modulation transformer in a smaller monolithic AM receiver and transmitter, the circuits can be much miniaturized.

At present Korean manufacturers are producing citizens-band transceivers using conventional discrete components for domestic market. These products are not suitable for export since neither new design nor new technology is involved. If the above mentioned new circuits and manufacturing technology are available to Korean industry, we will be able to export these transceivers.

The basic military transceivers of the Korean Army are old vacuum tube types. New transistorized transceivers shall be developed for them. These new transceivers shall utilize Korean electronic components partially.

NASA technology of miniature space communication systems can be very valuable in the development of these items, especially in the technology of high receiver sensitivity, low power consumption, and automatic voice switches of transmission.

INFORMATION AND ASSISTANCE OBTAINED DURING TECHNOLOGY FOLLOW-UP VISIT TO THE UNITED STATES

a. Citizens-Band Transceiver

During the visit to the United States there were technology transfers of receiver circuit miniaturization, receiver sensitivity increase, and power drain reduction.

a.1 Miniaturization techniques

a.1.1 Monolithic IC

The experimental production of the CLEM blocks (monolithic circuit boards developed for NASA by Westinghouse) had been stopped. Silicon General produces some similar kinds of monolithic circuit boards. One of the latter was found to be able to contain the local oscillator, mixer, and IF amplifier, exclusive of the IF transformers of a receiver.

a.1.2 Hybrid IC

In the hybrid IC miniaturization technique of Texas Instruments applied in the development of the TACAN PRC-95 set, IF resonance circuits are included in the IC's. This is an advantage over the monolithic technique which can put only active elements, capacitors, and resistors in a monolithic IC, but cannot put the three necessary transformers in it.

a.2 Sensitivity raising techniques

The high sensitivity circuit design of the RF amplifiers of EVGS (a personal transceiver used on the moon surface) and PRC-95 helped us with many design suggestions for wider operational range and smaller intermodulation distortion.

The cascade transistor circuit design used in the RF amplifiers of the Pocket Bell contains two RF amplifier stages and consumes least power. This is the best design to prolong the stand-by time of a receiver. This technique has been utilized along with the low noise transistors found during the visits to the semiconductor manufacturers.

b. Pocket Bell Systems

The technical data of the original BTL Pocket Bell and of various recently developed similar systems were obtained during the visit to the U.S. and have been very helpful in providing us with good design schemes.

The design data and the study of the inside structure of a pocket-type tone-modulated FM transmitter supplied us with the new-design concept of a miniature two-way paging. In particular, the special integrated antenna and hybrid-IC circuits can be used in a pocket size transceiver. A warning signal transmitter can be developed this way.

c. Military Transceivers

The PRR-9, a helmet-mounted reciver; the PRT-4, a hand-held transmitter with a small number of channels and medium range; and the PRC-100,

a hybrid-circuit transceiver with many channels and long range, were examined during the U.S. trip at RCA, Texas Instruments, and the Goddard Space Flight Center.

It was decided that the PRC-88, which consists of the PRR-9 and the PRT-4, could be modified into a single helmet-mounted transceiver. The transmitter will be controlled by a voice operated switch (VOX) similar to that in the EVCS. In the transceiver, hybrid IC's will be utilized and the cascade transistor circuits will be applied in the RF amplifier stage to minimize power consumption. For long-range communications the high sensitivity, high power output, and best antenna matching techniques of the EVCS and PRC-95 have been much utilized.

In order to increase the available number of channels the current analog tuning devices shall be replaced by digital frequency synthesizers that are easier to operate. Dr. Sohn at KIST is working on the development of digital frequency synthesizers utilizing C-MOS IC's for minimum power consumption.

SUMMARY OF APPLICATION ENGINEERING AND DEVELOPMENT WORK BY KIST

a. Citizens Band Transceiver

As shown in Fig 1, the transmitter part of the transceiver has a diode modulator (PCB at right) of a special patent of invention instead of the usual modulation and audio transformers (PCB at left). Fig 2 depicts circuit boards for the hybrid-IC IF amplifier and the monolithic-IC audio amplifier stages of the new transceiver (left) and the ordinary superheterodyne transceiver using discrete components (right). The case of the transceiver was originally designed to house the discrete electronics parts; now it provides extra space for easy tuning and adjusting services since IC's are used.

The audio IC stage has been designed to be cut off when no received signal is present in order to save the battery. In Fig 3 the transceiver with the latter circuit and a cascade RF amplifier of high sensitivity is presented.

b. Pocket Bell System

In the development of a pocket bell a hybrid-IC FM receiver and a monolithic-IC receiver have been compared. Hybrid-IC method consumes less power, utilizing a crystal filter and a high sensitivity RF amplifier. The hybrid-IC circuits are depicted in Fig. 4.

A warning signal transmitter with two tones has been developed and is shown in Fig 5. The right part is the transmitter and the left part is the receiver which includes two reed filters for frequency discrimination

with narrow band-pass characteristics. The upper part of the receiver shows signal indication lamps and a speaker.

c. Military Transceivers

An improved military transceiver has been developed from PRC-88 by putting the transmitter part into a case attached to the helmet, as shown in Fig 6. The small microphone at the right of the steel case includes a voice operated automatic switch (VOX). The transmitter at the left and the receiver in the middle have been housed in the steel case of the former receiver which is attached to a helmet. Fig 7 depicts the inside structure of the transceiver; the transmitter is at the left while the receiver is at the right. Again, the transmitter switching is done automatically by a diode switching circuit utilizing the microphone output power.

A hand-held transceiver with high output power and a voice-operated switch is shown in Fig 8. The hybrid-IC receiver and the transmitting power stage with its heat sink are at the top, the transmitter voice-operated switch and audio amplifier stage are in the center, and at the bottom is the battery.

In Fig 9 a two-watt output power transceiver is seen housed in a PRC-6 case. In Fig 10 a transceiver utilizing the same module components and an added frequency synthesizer that produces 50 channels selectable by easy dial switching is shown housed in a PRC-10 case. In these two transseivers discrete transistors are used, sensitivity and transmitting power output have been raised, while power consumption has been reduced compared with the original vacuum-tube type sets.

IMPLEMENTATION STRATEGY AND PRESENT STATUS

a. Citizens-Band Transceiver

The original transceiver has been modified by utilizing hybrid-IC's and monolithic IC's to make production and tuning adjustments easy and convenient. In the same size circuit board a transceiver with ten times the transmitting power will be developed. The transceivers to be sold within Korea have fixed minimum outside dimensions, hence only inside modifications are allowed.

A smaller size transceiver has been developed to be exported outside the country. The set has high sensitivity and can transmit signals at 49 MHz and 27 MHz. The IC components will be developed specially for the transceiver developments because the existing IC's are not well designed. A pencil size transceiver will be developed utilizing the resonance coils of the types used in the PRC-95.

b. Pocket Bell System

A pocket bell scheme has been applied to the development of a two tone FM-type warning signal transceiver. In the receiver part IC's and reed tone signal filters are used. A multiple-tone transceiver will be developed in the future.

As a future project a warning signal transmitter will be developed utilizing an integrated circuit antenna in the case. A short-distance type will be designed for home use and long-distance types for the armed forces and the police.

c. Military Transceivers

Modified PRC-6 and PRC-10 transceivers have been developed using modular circuits. After functional testing by the Korean Armed Forces, they will be released for mass production.

Two single-channel transceivers have been developed from the PRC-88 by utilizing hybrid-IC receivers and VOX-controlled transmitters. One is helmet mounted; it will be mass produced when a market demand is detected. The other is a hand-held unit; a plastic case will be designed for the non-military version.

CONCLUSIONS AND RECOMMENDATIONS

a. Conclusions

Special characteristics were added to the products by utilizing newly developed electronic parts and new technology of transceiver design.

In the development of urgently needed military and industrial transceivers the technology transfer brought more flexible and independent ability than the restricted method of international industrial cooperation could.

In the new domestic and foreign market for the citizens band transceivers, the technology transfer helped us greatly. The transferred technology shall be utilized immediately by the Korean industries.

b. Recommendations

For the consumer-oriented product development, technology should be transferred from both NASA and the commercial industries of the U.S.

The testing and characterization technologies should be added to the already transferred technologies.

Through the continued efficient technology transfers in the areas related to the present transfers, Korea can be developed. Thus technology transfers to developing countries are highly recommended.

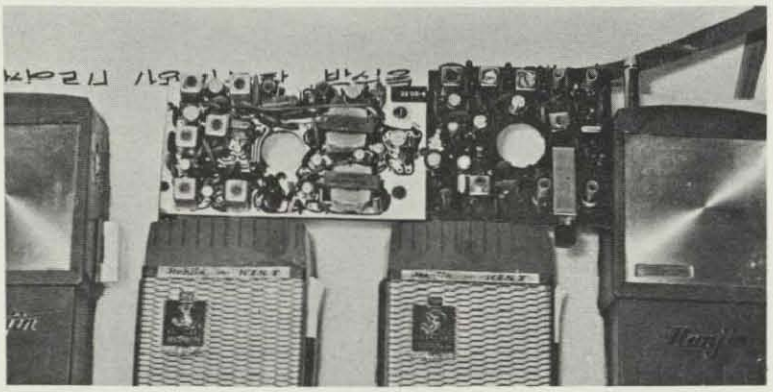


Fig. 1. Inside structure of the new transceiver utilizing a diode modulator (PCB at right) compared with the structure of the conventional transceiver (PCB at left).

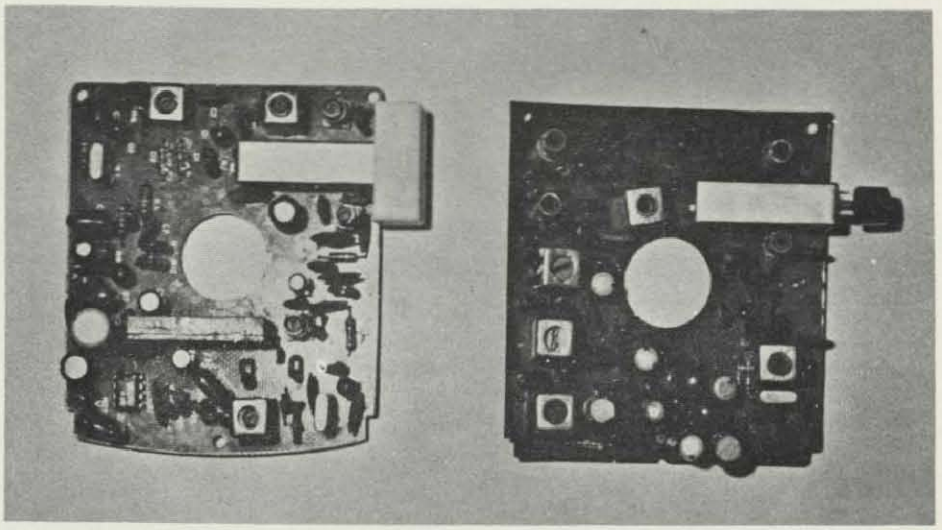


Fig. 2. The citizens band set using a hybrid circuit IF amplifier, a monolothic IC circuit audio amplifier (left) and the ordinary circuit using discrete components (right).

Fig 3. Transceivers utilizing modified audio receiver parts (for lower power consumption) and high sensitivity amplifiers.

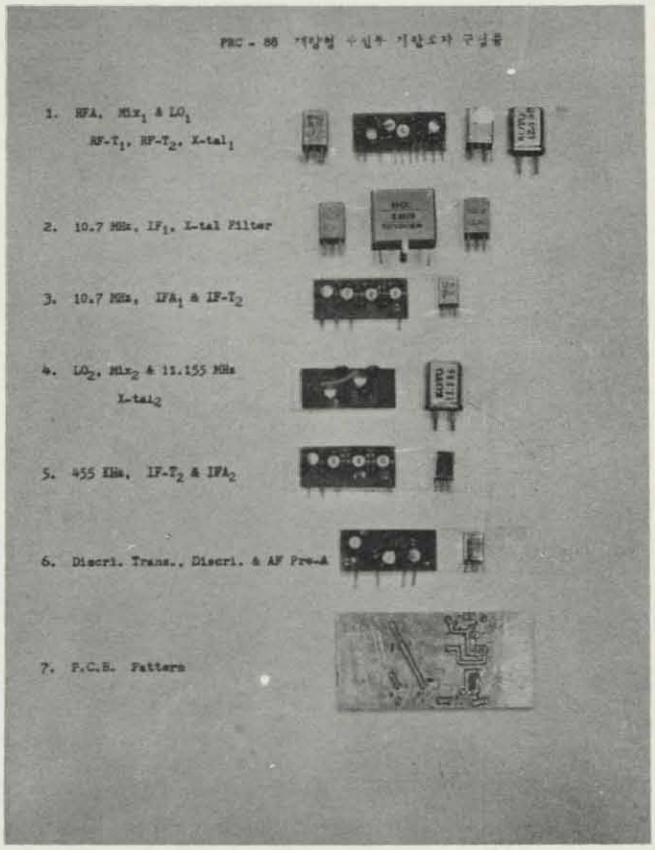


Fig. 4. Hybrid IC circuits

Fig. 5. Two-tone signal warning system consisting of receiver-indicators (left) and transmitter (right).

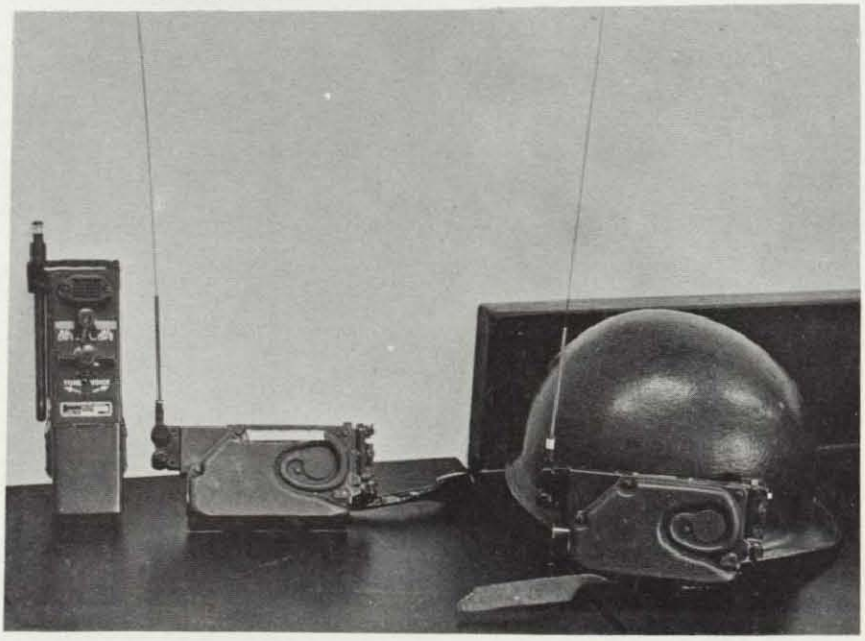


Fig. 6. The modified PRC-88 with both the transmitter and receiver in the helmet set (at right) compared with the separate system (at left).

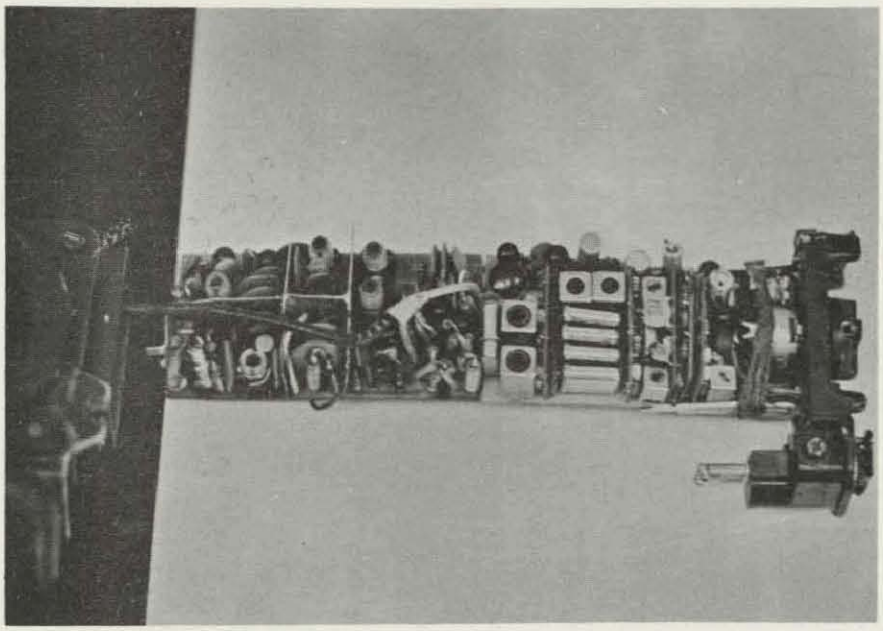


Fig. 7. The inside structure of the modified hand-held PRC-88 that can transmit and receive.

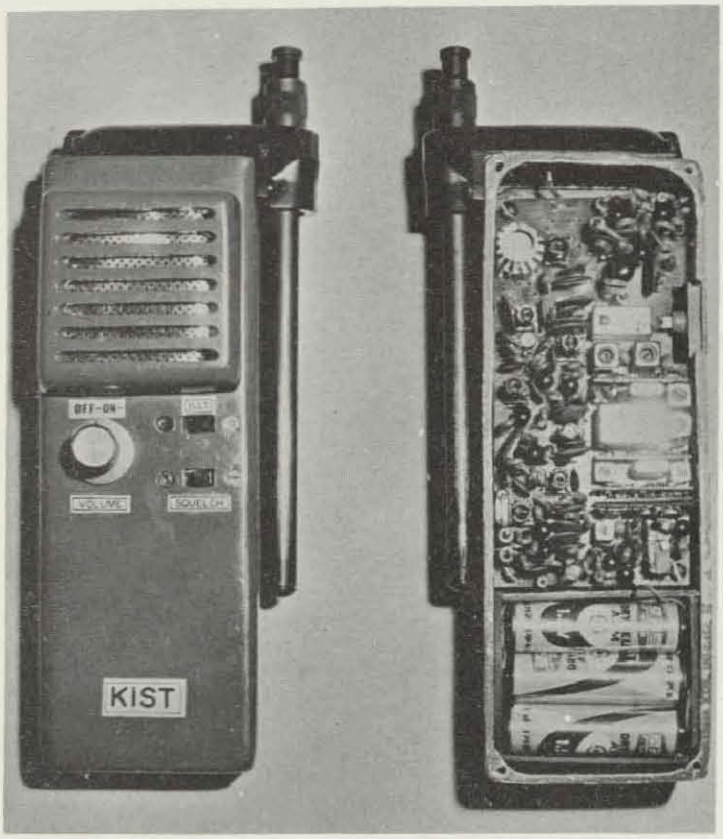


Fig. 8. A new transceiver utilizing press-talk switch

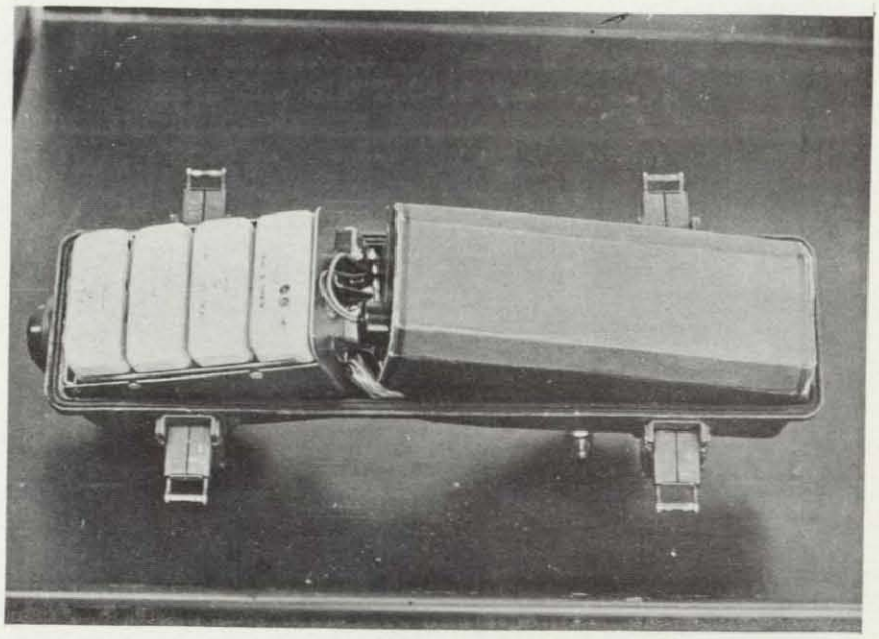


Fig 9. A new transceiver of module type inner construction.

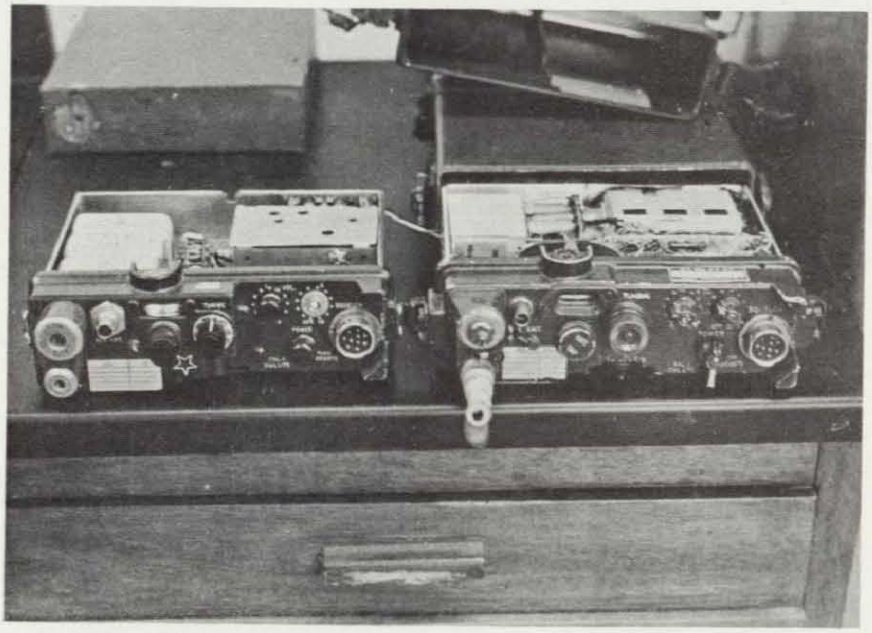


Fig. 10. Modified PRC-10 with module construction and digital frequency selection (at left) compared with the old PRC-10 (at right).

EE-3 HIGH-SENSITIVITY TRANSCEIVERS

Dr. Sung Jai Sohn was the KIST staff member responsible for directing the transfer activities related to this project. This is his report on those activities.

PROBLEM STATEMENT

There are four development subproblems under the title:

(1) Supersensitive FM Radio and TV Receiver

The phase-locked-loop high-sensitivity signal detection circuits are experimentally utilized in an FM radio and a TV receiver.

(2) Digital Frequency Synthesizer

The communication frequency channels can be selected by choosing the frequency numbers using this electronics systems in communication systems.

(3) TV Repeater

The development of a TV translator-repeater that receives a TV signal on one channel and transmits the signal at another channel has been started by KIST. Its performance specifications are being discussed with the broadcasting stations in Korea.

(4) 450-MHz Mobile Transceiver

This type of FM voice communication system is highly demanded for various purposes in Korea now. A research and development contract with the Korean Ministry of Science and Technology has been executed this year.

ARAC SEARCH RESULTS

For the EE-3 technology transfer, 49 microfiches and 19 hard copies of technical papers were obtained through ARAC. Among them the following papers supplied substantial technological information:

(1) Schilling, Donald L. and Billing, Joseph: "A comparison of the threshold performance of the frequency demodulator using feedback and the phase locked loop," A66-13587

(2) Balodis, M.: "Laboratory comparison of tanlock and phaselock receivers" A64-26472

(3) Acampord, A. and Newton, A.: "Use of phase subtraction to extend the range of a phase-locked demodulator" A67-18109

(4) Booton, Richard C., Jr.: "Demodulation of wideband frequency modulation utilizing phase-lock technique" A63-14705

(5) Suter, Charles F., Jr.: "Performance of a combination phase and frequency lock system" N67-37237

(6) Magasing, I.P.: "Airborne military transceiver finds room in crowded spectrum" A68-26017

(7) Sassler, Marvin: "A Phase locked demodulator for multichannel telephone traffic from satellites" A65-11338.

JUSTIFICATION FOR SELECTION AS INTENSIVE FOLLOW-UP PROBLEM

The technology of radio communication systems in Korea is limited to the basic assembly techniques of portable radios and black-and-white television sets. The design and development technology of supersensitive communication systems is needed.

The phase-locked-loop signal detection circuits utilized in space communication systems are beginning to be applied in consumer-oriented communication systems and broadcasting systems. In the development of new communication systems, this technology should be included. The range of communication systems can be extended by this improved signal detection system.

Frequency synthesizers are used to generate a large number of discrete frequencies from which one may be selected for use. Such a device finds wide use as a laboratory signal source and in the frequency selection function of communications equipment. The technology of digitally controlled frequency synthesizer is needed in the development of a mobile VHF transceiver.

In Korea economical TV repeater systems are needed, because 70 per cent of the land is covered by hills and mountains that obstruct the TV broadcasting waves. The translator-type repeaters that receive the broadcast on one channel and transmit at other channels are most suitable.

At the same time, the technology of VHF mobile communication system is required. In Korea new industries are being set up in rural areas, and many of them need this type of communication system for business.

INFORMATION AND ASSISTANCE OBTAINED DURING TECHNOLOGY FOLLOW-UP VISIT TO THE UNITED STATES

During the Phase III trips in the United States, much technology of high-sensitivity transceivers was acquired. The details of the acquired technology are described below. The technology was acquired in the form of written notes, printed sheets and books, and memory.

Of the technologies relevant to high-sensitivity transceivers, that utilizing the phase-locked-loop or PLL system was sought after with highest priority. The electronic schematic diagrams, descriptions of physical layouts, and component descriptions of PLL's were gathered. Sufficient technology of this super-sensitive detection system for both AM and FM transmissions of about 50 MHz carrier frequency was acquired during the trips to permit development of KIST. Thus, the primary objectives of the trips were accomplished.

Both the discrete-component PLL technology and IC-component technology were acquired. The visit with Mr. Ulicki of Holobeam, Inc., was most productive for the discrete component technology. The visit to Motorola Semiconductor Products Inc., Phoenix, Arizona and Fairchild Semiconductor Co., Mountain View, Calif. were most productive for the IC-component PLL technology. It is regreted that little PLL technology could be acquired on the visit to the Jet Propulsion Laboratory, Pasadena Calif. were much original work in PLL technology was performed under NASA support, because most of the original workers had changed employers.

The PLL technology of higher frequency, from 50 to 1,000 MHz, was also acquired during the trips. S-band injection-locked oscillator technology was acquired from Mr. Ruthroff of Bell Telephone Labs., Crawford Hill, N.J. A technical session on "L-band TR Module for AN/PRC-95," by Roger Weber and James Chapman, Texas Instruments, Dallas, Texas held at IEEE 71 International Convention and the visit to Texas Instruments were also productive. During the two visits to Goddard Space Flight Center (GSFC), much information on communication circuits was acquired from Mr. L.L. Kleinberg of GSFC and Mr. Sam S. Hartin* of Martin Marietta Corporation, Orlando, Florida.

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* Sam Hartin, "Large Scale Integration of Communication Circuits," Final Technical Report, prepared for Goddard Space Flight Center, Martin Marietta Corp., Feb. 1971

The technology of PLL-method digital frequency synthesizer was acquired. The digital frequency synthesizer is being increasingly used in communications systems where requirements include frequency-stable multichannel operation and high speed channel selection. A frequency synthesizer consists of a PLL, one or two crystal-controlled oscillators, and several frequency dividers. The technology of frequency synthesizers for both AM and FM communication systems was acquired. The PLL frequency synthesizers of miniature packaging and low power dissipation were explained by Mr. Ulicki of Holobeam, Inc., and Mr. Roger Doventier of RCA, Camden, N.J. The technology utilizing IC's was acquired on the visits to Motorola Semiconductor Products Inc., Phoenix, Arizona, Fairchild Semiconductor Co., Mountain View, Calif. and Signetics Corp., Sunnyvale, Calif.

SUMMARY OF APPLICATIONS ENGINEERING AND DEVELOPMENT WORK BY KIST

(1) Supersensitive FM Radio and TV Receiver

The experimental development of a supersensitive FM radio has been accomplished. The radio utilizes a PLL detection system for the increased sensitivity and stable tuned-state. The rest of the work will be actual design of a home-oriented product. This work will be finished by August 1972. The PLL techniques will be used also in carrier generators in several communication systems that will be successively developed at KIST in the future.

A TV receiver with PLL detection has not yet been developed successfully due mainly to the shortage of research funds and research manpower.

In the development of phase locked loops several electronic circuits were experimentally develop and compared: three different types of circuits utilizing discrete electronic components, and two circuits combining monolithic integrated circuits and discrete components.

The main difference between the discrete component PLL's is the structure of the voltage-controlled oscillators (VCO). One VCO used active controllable capacitance in the resonance circuit. Since the capacitance changes linearly with the bias voltage, the oscillation frequency also changes. The third VCO was a current-controlled stable multivibrator.

Some monolithic integrated circuits manufactured as block components and functioning as phase comparators or VCO's contain completely different electronic circuits for the same function. For example Motorola and Fairchild make digital phase comparators while Signetics makes analog phase comparators. Further, the digital phase

comparators of Motorola work on a quite different principle from Fairchild's. Hence, the integrated circuits were analyzed and experimentally compared. After careful evaluation, Signetics monolithic integrated circuits were chosen for the research and development. As they can generate high frequencies, up to 60 MHz, and require few associated electronic parts, demodulation at the intermediate frequency was very convenient.

(2) Digital Frequency Synthesizer

A digital frequency synthesizer has been developed. This will be inserted in a military transceiver under development at KIST. It can generate any one of seventy available sine waves with 50 KHz spacing by digital selection of the frequency number.

In the development, latest types of monolithic IC's are utilized in the digital freqency dividers and in the voltage-controlled oscillator parts of the system. Later an improved system will be developed that will consume only half the power of the present system.

The circuit diagram of the frequency synthesizer is shown in Fig. 11. In addition to the circuit a wide-band pass filter and a mixer have been developed. The output from the frequency synthesizer is mixed with a modulated signal and is passed through the filter in a transmitter.

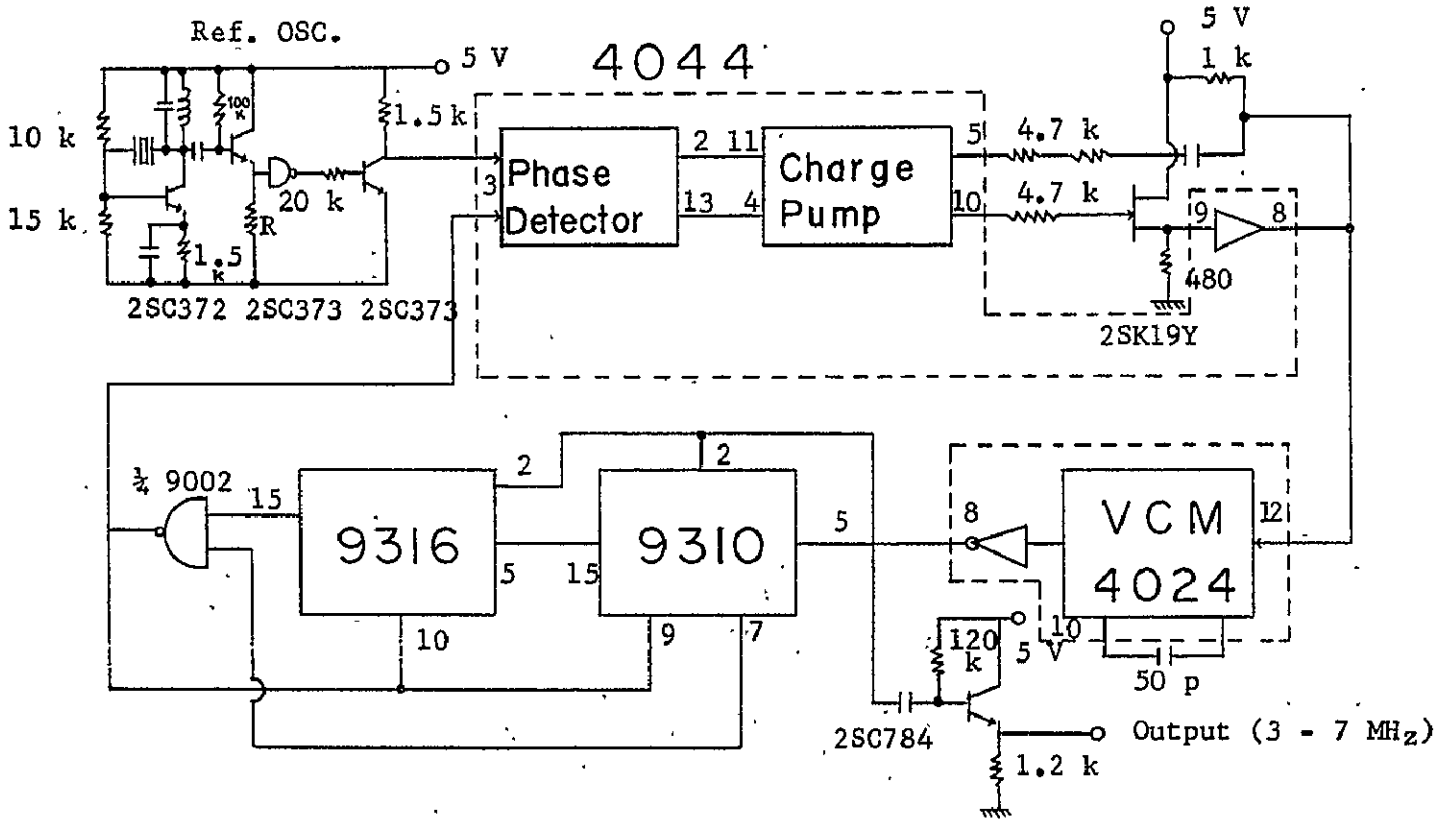

Fig. 11. A brief circuit diagram of the frequency synthesizer.

The photographs show the developed frequency synthesizer structures. Fig. 12 shows frequency selection knobs at the front control panel of a modified military radio set PRC-10. Fig. 13 shows the printed circuit boards that constitute the frequency synthesizer. Fig. 14 is the bottom side picture of a circuit board.

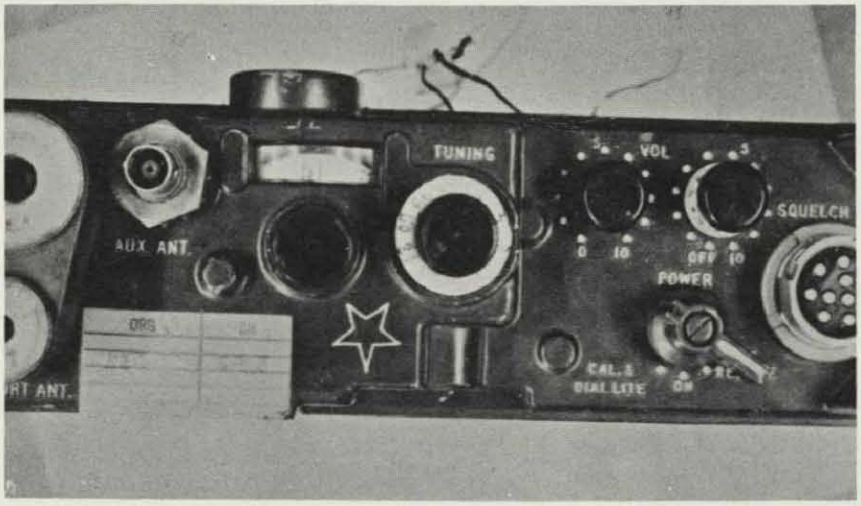

Fig. 12. Front control dials of the radio transceiver

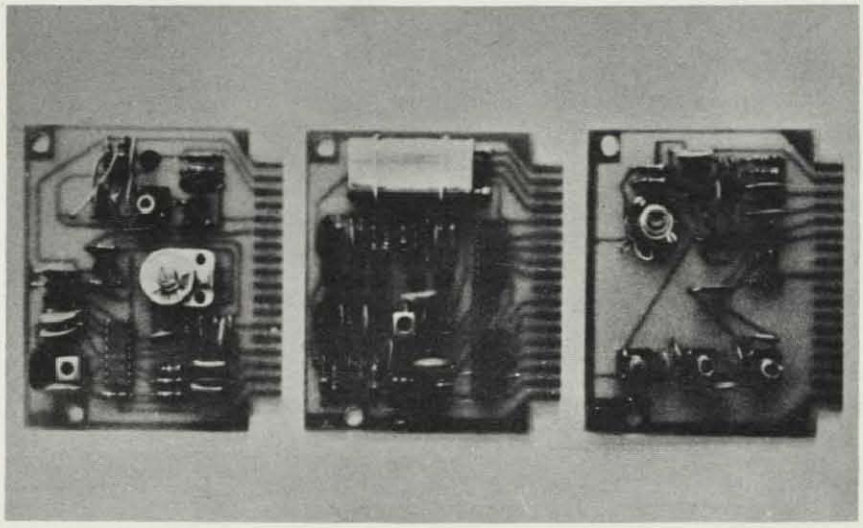

Fig. 13. Electronic parts distribution

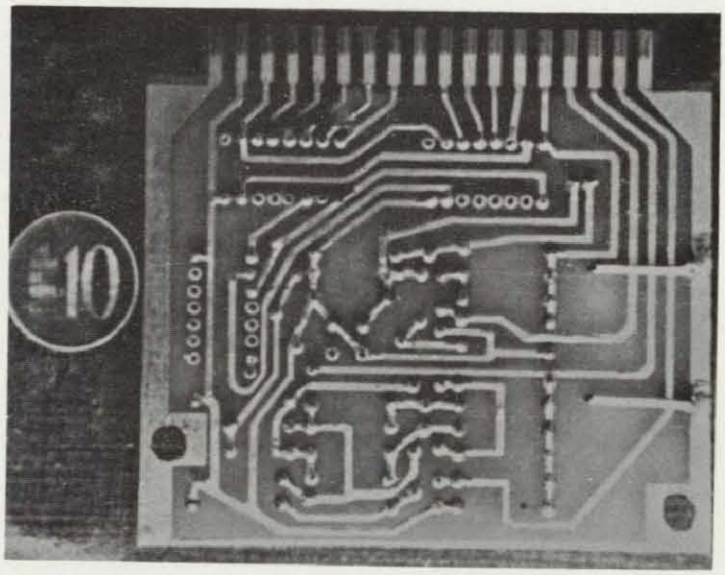

Fig. 14. Circuit board containing oscillator and frequency dividers

(3) TV Repeater

The Korean Broadcasting System and the other Korean broadcasting stations plan to purchase many TV repeating systems in the next few years. The TV translator-repeaters that receive broadcasts on one channel and transmit through other channels are greatly needed. The development project of a TV translator has just started by KIST, and will be finished by the end of 1972. The most difficult part of the project is to develop wideband VHF amplifiers and crystal-controlled oscillators which generate accurate frequencies throughout the temperature range of the natural environment.

Fig. 15 is a brief functional diagram of the translator, which will utilize transistors as its active components. The received TV signal is amplified and then mixed with proper-frequency wave generated

by the first oscillator. The output from the mixer proceeds to a high-gain IF (intermediate-frequency) amplifier. The IF signal is converted to the transmit-frequency signal which is then amplified and radiated from an antenna.

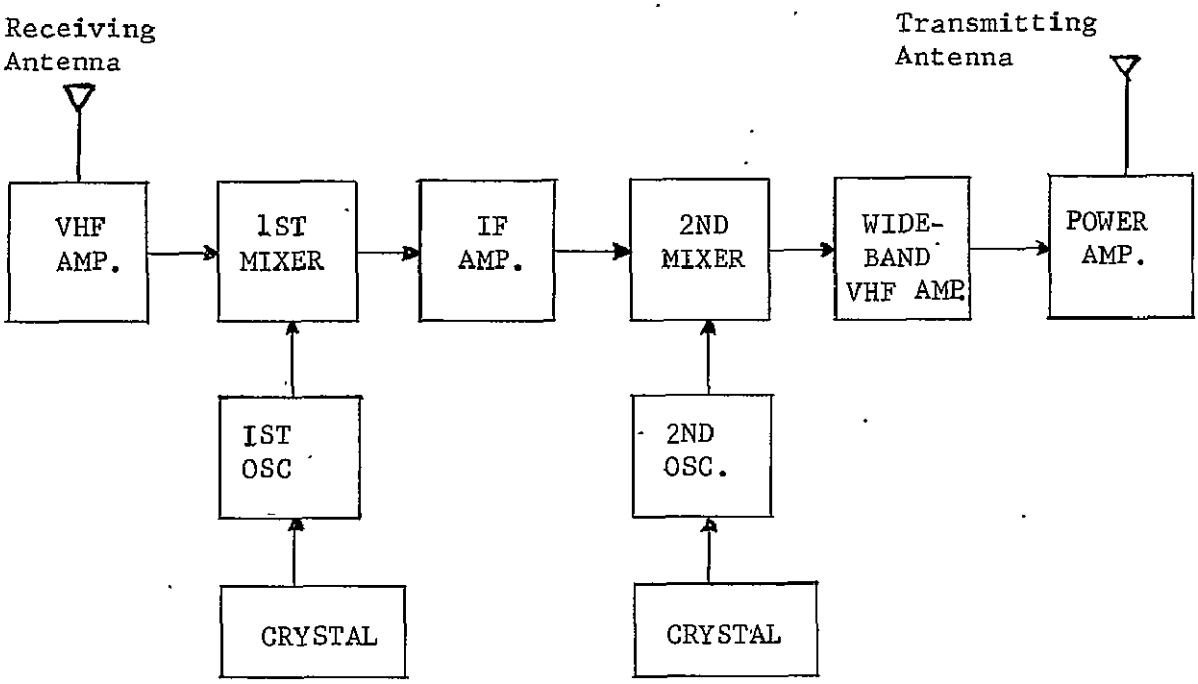

Fig. 15. Structure of a TV translator

(4) 450-MHz Mobile Transceiver

The demand for 450-MHz UHF transceivers is high in Korea at present. The transmitter part of an industrial-use mobile transceiver will be developed in 1972. The necessary electronics parts have been ordered for purchase.

The mobile transceiver will use the 12 volt car voltage and will accept either case of polarity grounding. The transistors will be the main active devices and monolithic-IC circuits will be utilized at the proper functional locations. The signal frequencies from the crystal-controlled oscillator shall be stable for the environmental temperature range. The transmitted output power will be 5 Watts and the modulation type will be 16 F3. The spurious radiation shall be small, and audio distortions shall also be sufficiently small.

The overall functional diagram of the transceiver is shown in Fig. 16. The modulated signal is multiplied and amplified, and the oscillator circuit will contain plug-in capsule for easy frequency changes. The output stage will be protected by an automatic switch controlled by the antenna radiation condition.

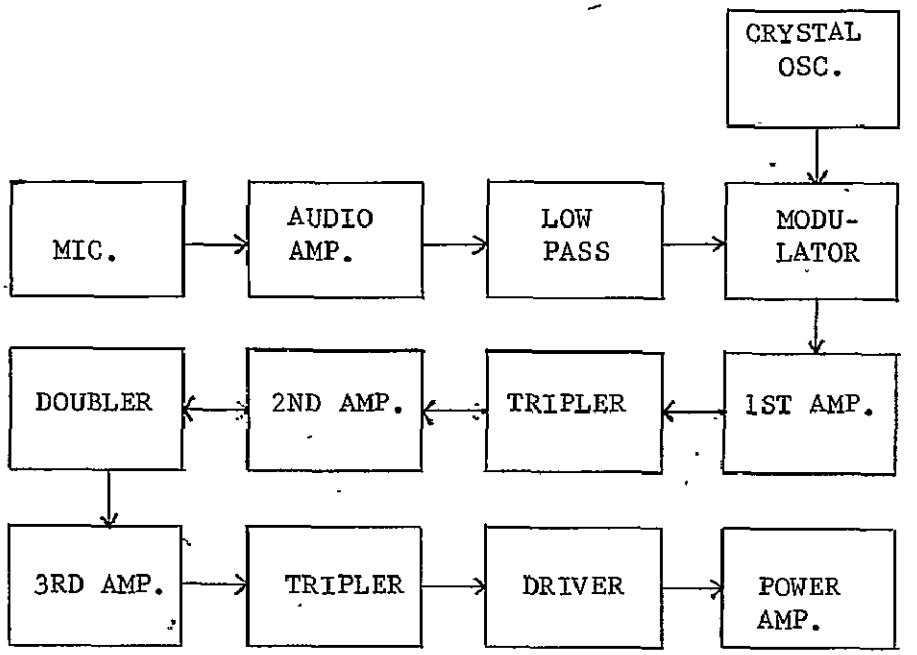

Fig. 16. Functional diagram of a mobile transmitter.

IMPLEMENTATION STRATEGY AND PRESENT STATUS

(1). Supersensitive FM Radio and TV Receiver

An FM radio of high sensitivity can be manufactured in Korea utilizing the PLL detection technique developed at KIST. The business arrangement of technology transfer to a Korean industry has not yet materialized. However, the PLL technology will be applied to signal detection systems or signal oscillators in several types of communication systems in Korea in the near future.

The coherent detection of the video signal of TV is a new technology in the advanced countries. The technology is being intensely studied at the TV manufacturers in the U.S. The technical problem is to realize such a detection system utilizing low cost electronic parts. This research and development work has been continued at KIST.

(2) Digital Frequency Synthesizer

Korea currently requires modern military communication systems. Digital frequency synthesizers will eventually be utilized in the modified communication systems of PRC-77 transceiver type and PRC-74 SSB transceiver types.

Consumer-oriented FM receivers are being experimentally developed utilizing digital frequency synthesizers in the developed countries. The high-performance FM receivers with digital frequency synthesizers can be manufactured in Korea for export.

(3) TV Repeater

At present the Han-Jin Electronics Company in Korea is much interested in the production of TV-translator-repeaters using the KIST know-how. All three TV broadcasting systems in Korea are interested in purchasing quality TV-translators made in Korea. This year the KBS is importing 12 TV translators at a cost of about 5,000 dollars each.

(4) 450-MHz Mobile Transceiver

Korea is importing hundreds of 450-MHz transceivers this year at a cost of 500 to 1,300 dollars each. The Han-Jin Electronics Co. is much interested in manufacturing them using KIST technology through a proper contract. We are preparing the contract at present.

The 450-MHz UHF technology, which is very valuable to communications development in Korea, will be completely mastered by the end of this year under the research and development contract with the Ministry of Science and Technology. Eventually some communication systems of this technology will be exported also.

REMARKS AND RECOMMENDATIONS

This hard transfer of technology has been successful. The technology that had been located through the Phases I and II of this NASA technology utilization project has been sought out, acquired, and developed, during Phase III.

Much unexpected delay has been encountered in the development of the prototypes due to the long purchasing lead-time of the necessary materials and components. It is highly desirable to arrange for some convenient electronics parts purchasing agents in the U.S. and Japan.

It must be understood that the market for the products under development will be improving due to many factors, including the rapidity

of Korean industrialization and beneficial government policy. There can be no doubt that every sub-project development under the title of this technology transfer is worth many times the hard trial, though some of the fruits may not have great economic impact.

EE-18 INDUCTORLESS COMMUNICATION CIRCUITS

The KIST staff member responsible for transfer activities on this project was Dr. Song Bai Park. His report on these activities follows.

PROBLEM STATEMENT

Inductorless active filters offer many advantages in communication circuits in the VHF and UHF ranges. Among these are economy in fabrication and ease of miniaturization. Mastery of the design principles and fabrication techniques of this technology will provide a basis for developing commercial applications.

ARAC SEARCH RESULTS

One document with significant amounts of relevant information was retrieved through ARAC. This was "Large Scale Integration of Communication Circuits" by Sam Hartin of the Martin-Marietta Corp.

JUSTIFICATION FOR SELECTION AS INTENSIVE FOLLOW-UP PROBLEM

Inductors are bulky, heavy, expensive, and difficult to be realized as ideal elements. Elimination of coils and transformers in electronic circuits is therefore highly desirable from the standpoint of economy and, in particular, miniaturization. This has been accomplished to a considerable extent in the low frequency range but design of active RC filters in the VHF and UHF ranges is a reletively new areas of investigation.

Since a number of coils and transformers are commonly used in a communication system for the purpose of tuning and impedance matching, elimination of inductors will bring a significant reduction of the overall size of the system.

Mastery of the design and fabrication techniques of inductorless circuits is important in Korean communications circuit development for the following reasons:

(1) KIST is currently engaged in research on and development of thick- and thin-film IC's. If inductorless communication circuits can be realized in either of these forms, micro-miniaturization of communications equipment will be possible.

(2) During 1972, KIST would be developing mobile communication systems of 50, 150, and 450 MHz for military and commercial applications. Inductorless circuits could be utilized effectively in these systems.

(3) A continually increasing international market for minaturized communication equipment is foreseen.

INFORMATION AND ASSISTANCE OBTAINED DURING TECHNOLOGY FOLLOW-UP VISIT TO THE UNITED STATES

Invaluable information was obtained on the design principle of inductorless band-pass filters in the VHF and UHF range, from the discussion with Mr. L. Kleinberg of Goddard Space Flight Center, the inventor of this technology. It was stressed that this technology was still experimental and required theoretical analysis to allow practical production applications. An experimental sample of inductorless UHF filter constructed at GSFC with discrete components was obtained.

Information on computer-aided design of miniaturized band-pass filters was obtained from Dr. W. Gaertner, Gaertner Research Inc., Stamford, Conn., who used a circuit configuration similar to Kleinberg's but a different design principle requiring the use of inductors. A band-pass filter of his design fabricated by the thin-film technology was shown.

The visit to Ames Research Center, Moffett Field, Calif., gave a chance to discuss Dr. W. Kerwin's work on distributed RC line networks and to obtain his technical reports.

Discussions with Dr. H. Choi of Jet Propulsion Laboratory, Cal. Tech, Pasadena, Calif., yielded information on the application of surface wave devices and active filters in space communications. Pertinent technical papers were obtained.

The feasibility of application of the organic semiconductor gas sensor developed at McDonnell-Douglas to fire alarm systems was discussed with Dr. N. Byrd.

Knowledge of electronic production facilities and in particular, microelectronic facilities was obtained from inspection tours to various research institutes and manufacturing companies including Martin Marietta

Co., Orlando, Fl. and TRW, Semiconductor Div., Lawndale, Calif. This knowledge may be useful in the future expansion of microelectronic facilities at KIST.

SUMMARY OF APPLICATIONS ENGINEERING AND DEVELOPMENT WORK BY KIST

The primary objective of the present investigation is to obtain inductorless active band-pass filters having the following characteristics:

(1) High gain at the desired center frequency in the VHF or UHF range.

(2) High Q.

(3) Low noise figure.

(4) Low sensitivity to change of temperature.

(5) Symmetrical frequency response.

(6) Linear performance (wide dynamic range).

(7) Low sensitivity to changes of element values.

Truly inductorless filters with various circuit configurations and various transistors have been designed, constructed, and tested at our laboratory. All of them were not satisfactory in one respect, namely, temperature stability (this may not be surprising since one knows that active RC filters in the LF range also are very sensitive to temperature change). It was found, however, that introduction of a small inductance in a certain part of the transistor circuit makes the filter practical in most applications with respect to temperature change. The inductance required is so small even at 10 MHz that integration of it is no problem. Hence our object of miniaturization was achieved. It is interesting to note that the sample obtained from GSFC also includes an inductance at a critical point but it is more sensitive to temperature change than the one built at our laboratory.

Fig. 17 shows the circuit configuration of the basic active filter under an intensive investigation at this laboratory.

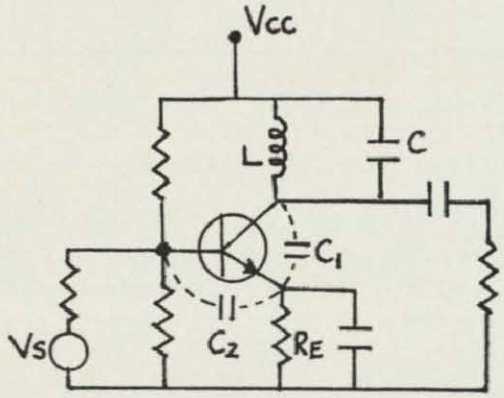

Fig. 17. Basic active filter circuit.

Here, L is a small inductance whose value depends on many factors: operating frequency, transistor characteristics, supply voltage, and other circuit parameter values. Typically,

$$L < 5 \text{ nh for } f_o \simeq 450 \text{ MHz}$$

$$L < 50 \text{ nh for } f_o \simeq 50 \text{ MHz}$$

$$L < 150 \text{ nh for } f_o \simeq 10 \text{ MHz}$$

where f_o is the resonance frequency. Notice that an inductance of 150 nh can be integrated readily by the present thin-film or thick-film technology. In general, the smaller L is, the larger C must be to obtain the desired resonance frequency. C should have a proper negative temperature coefficient for compensating the thermal dependance of f_o. C_1 is required to get a sufficient negative output conductance at the collector terminal, particularly at lower frequencies. C_2 is less effective than C_1 for this purpose. R_E is a thermistor for compensating gain change due to temperature change.

It was found a greater temperature stability can be obtained by connecting an RC coupled common-emitter stage (operating below the the alpha-cutoff frequency of the transistor of that stage) to the collector of this amplifier and using a thermistor for the emitter resistance of the second stage, instead of the first stage. In this way, the following characteristics were obtained at f_o = 50 MHz:

Overall gain $>$ 45 dB

Gain change $<$ $\pm$ 2 dB over -5 to 50°C

Resonance freq. change $<$ $\pm$ 40 KHz over -5 to 50°C

Q $>$ 200.

Fig. 18 through 21 illustrate the experimental set-up and the characteristics of one of the VHF active filters constructed at this laboratory. Using the same basic circuit configuration a complete system of 50 MHz FM receiver was constructed.

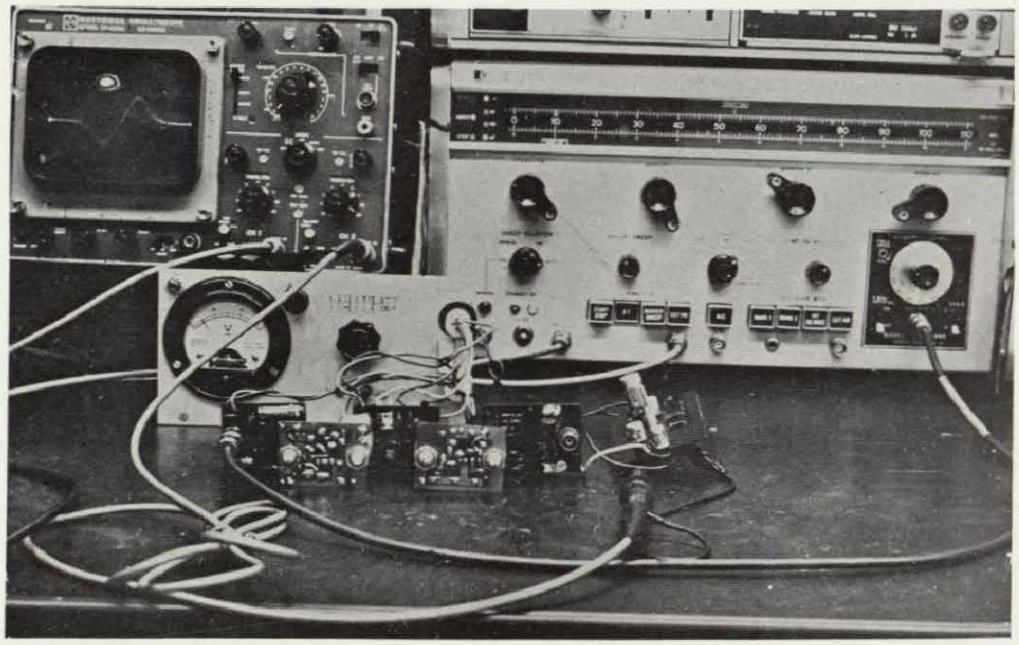

Fig. 18. Experimental set-up for VHF FM receiver using active band-pass filters. From left to right, the PCB's are 1-stage RF amplifier; crystal oscillator, multiplier, and mixer; 1-stage limiter; discriminator; and OTL audio amplifier.

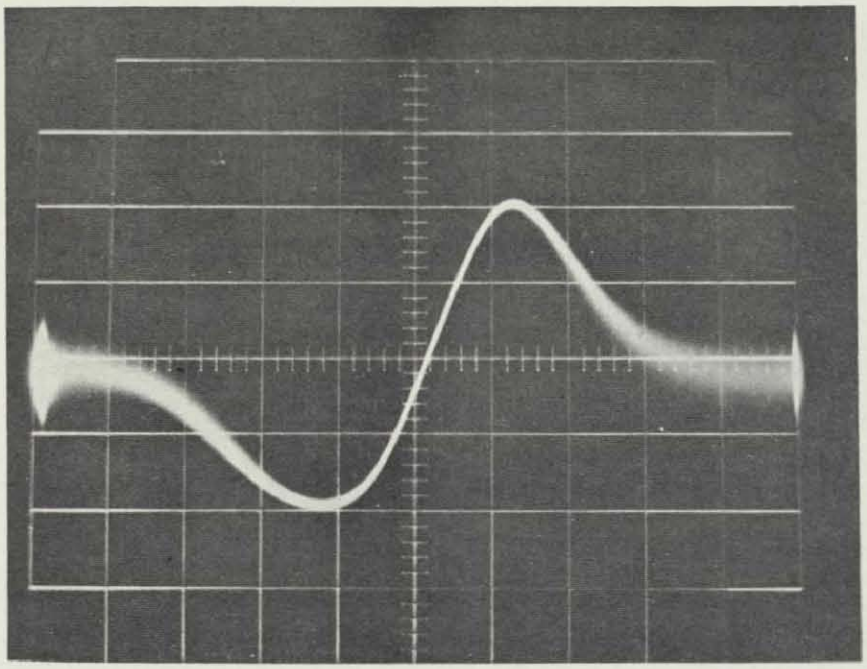

Fig. 19. Overall characteristics of the FM receiver (-90 dBm sweep input, vertical scale = 20mV/div., horizontal scale = 100 KHz/div.).

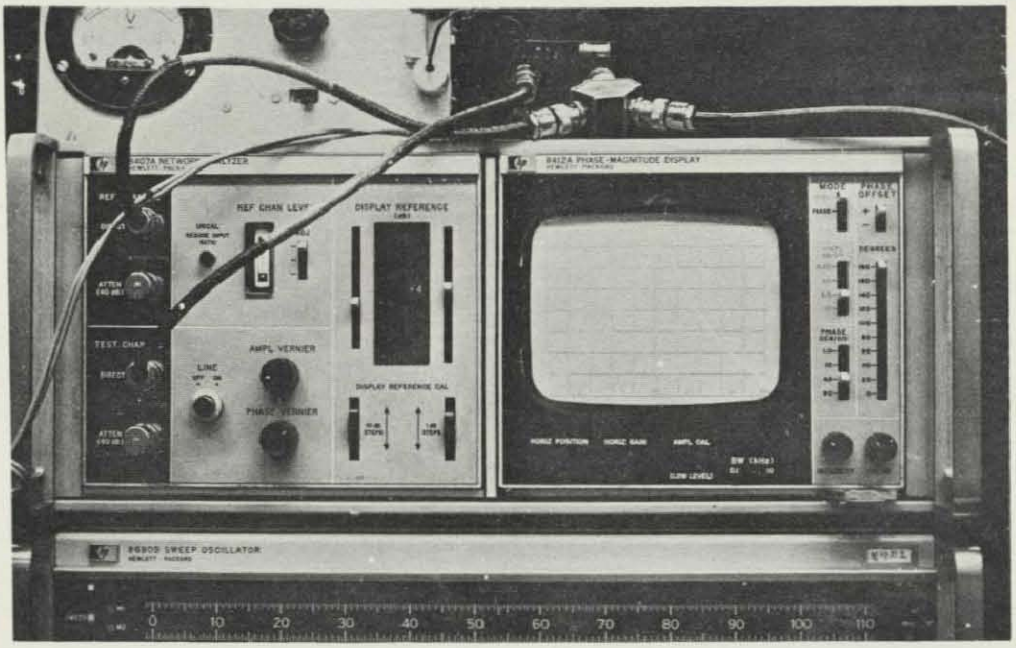

Fig. 20. Frequency response of an active band-pass filter (center freq. = 53.4 MHz, power gain = 41.5 dB, horizontal scale = 100 KHz/div.).

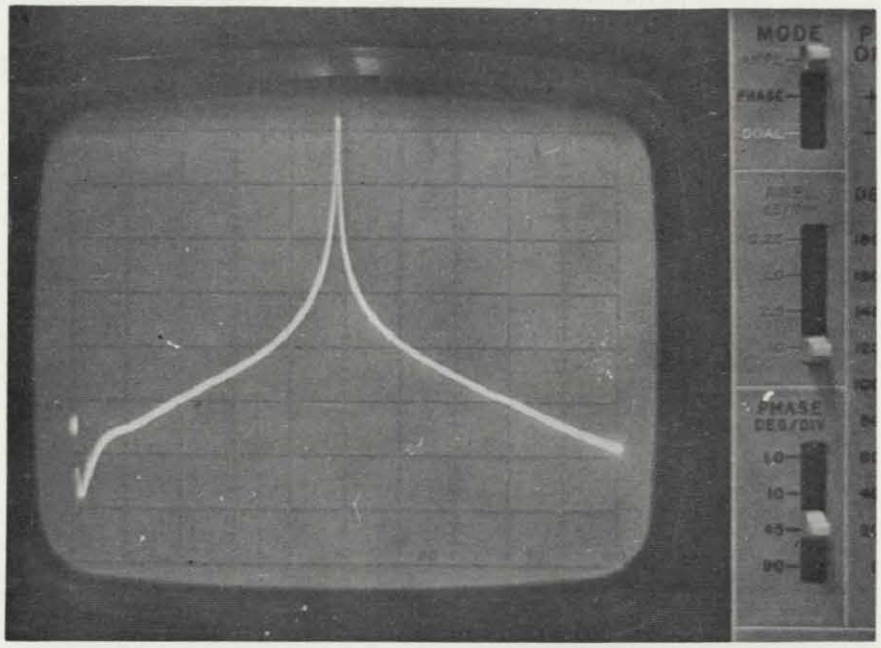

Fig. 21. Frequency response of the same filter with a compressed horizontal scale (1 MHz - 100 MHz).

IMPLEMENTATION STRATEGY

The following strategy was designed for implementing the transfer of inductorless circuit technology to Korea. The object of the program is the construction of miniaturized FM receivers of 50, 150, and 450 MHz.

Phase I — Design and Breadboard the Receiver Circuits

A thorough study is made of the basic band-pass active filter circuit, in particular its temperature stability. Each block of the receiver circuit is built using discrete components. Then discrete component breadboards are assembled in receiver form to verify operating performance of the complete system.

Phase II — Miniaturize the Breadboard Circuit in IC Form

The same steps as in Phase I are followed to miniaturize the breadboard circuit in thick-film IC form.

Phase III Study Problems Associated with Mass Production

Problems associated with mass production such as component tolerance and increase of yield are studied before transferring the technology to the industry.

PRESENT STATUS OF IMPLEMENTATION

Phase I of the implementation strategy has been completed despite the unexpected pitfall of temperature instability in the design of active RC filters. Now that a satisfactory solution for this most important problem has been obtained, we can proceed with Phase II. However, some delay in carrying out the project is expected since the thick-film hybrid IC facilities at KIST have been returned to their original owner, a Korean company. Meanwhile research to further improve the temperature stability will be continued.

The FM receiver for the weather satellite Automatic Picture Transmission ground facility is an ideal application of this active filter. We intend to fabricate this receiver circuit in a thick-film hybrid form as soon as the facilities are available.

CONCLUSIONS AND RECOMMENDATIONS

Research funds for the design of inductorless VHF FM receiver circuits have been provided by KIST. This is a one-year project starting in September, 1971. On the basis of current progress, one domestic manufacturer, Han Jin Co., has displayed an immediate interest in the outcome of this new technology.

The greatest finding so far is the fact that modification of the circuit configuration and introduction of a very small inductance compatible with miniaturization bring forth a significant improvement in the temperature stability.

Active filters in the VHF and UHF range are still in the experimental stage of development even in the United States but every effort will be made at this laboratory to bring this technology to production applications.

MM-4 TANTALUM SOLID ELECTROLYTIC CAPACITORS

Drs. Young Ku Yoon and Dong Nyung Lee were the KIST staff members engaged in this intensive follow-up project. The following is their report on the transfer activities undertaken to bring this technology to Korea.

PROBLEM STATEMENT

Tantalum solid electrolytic capacitors have many advantages over capacitors of other types. These include larger capacitance per unit volume, lower cost of production, absence of need for hermetic sealing, low power factor and superior temperature characteristics. They are currently being used in increasing quantities in electronic equipment where components of high quality, high reliability, and long life are required. The rapid growth of the domestic Korean electronics industry and its entrance into the international market would be greatly helped by this production technology.

ARAC SEARCH RESULTS

The ARAC search of the NASA Aerospace Data Bank produced many reports pertinent to the technology of tantalum solid electrolytic capacitors which had been submitted to the U.S. Army Electronics Command. The U.S. industrial companies that have conducted research and development under contract with the government are Sprague Electric Co., Cornell-Dubilier (Electronics Division of Federal Pacific Electric Co.), General Instrument Corp., P.R. Mallory & Co., Inc. and General Electric Co.

The object of their R & D work was to establish the capability to mass produce tantalum capacitors and to develop production engineering measures for improved reliability of tantalum capacitors.

JUSTIFICATION FOR SELECTION AS INTENSIVE FOLLOW-UP PROBLEM

The tantalum solid electrolytic capacitor is an important component that is increasingly required in the manufacture of industrial and consumer electronics and military communication equipment. The potential Korean market for the tantalum capacitor is estimated at one million dollars annually and should grow rapidly in the future. Korean industrial concerns desire to produce the tantalum capacitor and are interested in acquiring the technology of tantalum solid electrolytic capacitors has been performed at KIST since early 1971. Tai-Han Electric Wire Co., Ltd., Sam-Sung Electronics Co., Ltd. and Sam-Wha Condenser Industry Co., Ltd. have indicated their interest in working with KIST on this project.

INFORMATION AND ASSISTANCE OBTAINED DURING TECHNOLOGY FOLLOW-UP VISIT TO THE UNITED STATES

Manufacturing plants of Sprague Electric Co. and Cornell-Dubilier (Electronics Division of Federal Pacific Electric Co.) were visited to obtain an overview of the tantalum capacitors industry, including production facilities, capital requirements, and technology content; to explore what production equipment and what engineering services can be purchased from the U.S. firms; and to have discussion of a general nature with technical people regarding R & D and market trends.

Bell Telephone Laboratories was visited to have technical discussions with the authors of publications on tantalum capacitors in the open literature.

Kawecki Berylco Industries, Inc., a producer of tantalum powder was visited to assess it as a potential source of supply. Information regarding their products and prices was obtained. They were also kind enough to provide samples of their products, including two pounds of tantalum powder and some tin-coated nickel wire.

SUMMARY OF APPLICATIONS ENGINEERING AND DEVELOPMENT WORK AT KIST

Processing variables of the most common tantalum solid electrolytic capacitor (7 μ fd - 35V rating) were investigated by following the fabrication flow chart given in Figure 22. Results of this work are summarized below.

Satisfactory pellets were obtained by sintering at 2,000 to 2,100°C for 30 to 50 minutes in a vacuum of 10^{-4} mm Hg.

When sintered pellets were anodized at 200 volts, the rate of anodization became greater with increasing sintering temperature and time. This was accounted for by the improved current efficiency due to purification of sintered pellets and the decreased surface area of pellets during sintering.

Anodized pellets were impregnated with manganese nitrate which was converted to manganese dioxide by pyrolysis. Pyrolysis was performed a total of 12 to 15 times to obtain tantalum capacitors of good quality. Pyrolysis temperature had to be kept as low as possible, and pyrolysis time had to be kept as short as possible.

Best results were obtained when the reanodization voltage was 1/3 of the initial anodization voltage.

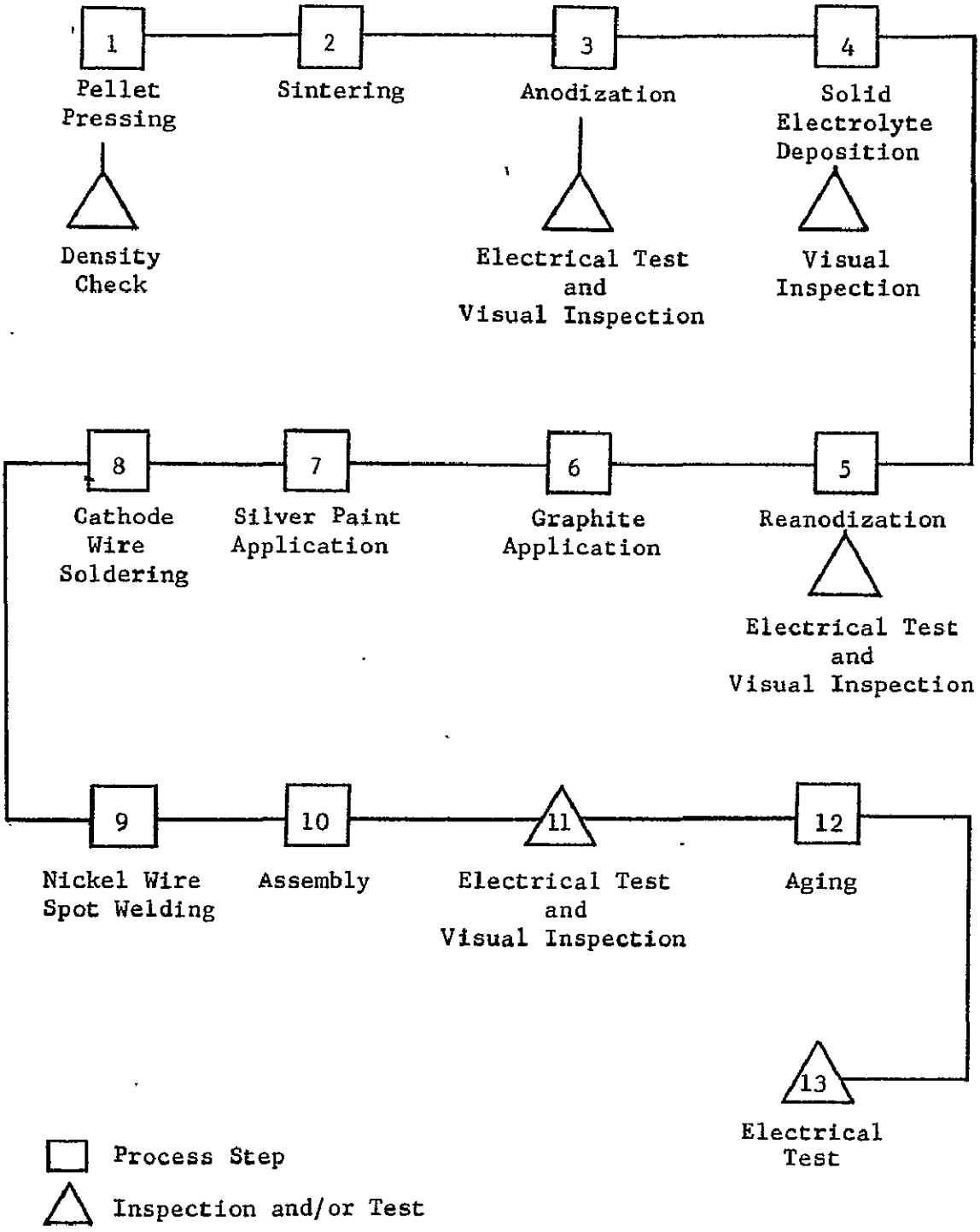

Fig. 22. Process flow chart for tantalum solid electrolytic capacitors.

After reanodization, a layer of graphite and one of silver were applied to pellets by dipping them sequentially into graphite and colloidal silver solutions. The concentrations of the solutions and curing temperatures had to be carefully controlled to obtain a uniform and satisfactory coating.

Assembled capacitors were subjected to specific conditions of voltage, temperature and series resistance for specific periods of time, both to stabilize their electrical properties and to detect defective capacitors.

Aged capacitors showed increased equivalent series resistance due to an increase in the diffusion layer of impurity in the oxide film.

Figure 23 shows a photograph of samples of tantalum solid electrolytic capacitors fabricated at KIST.

The following references contain more detailed information regarding this work:

(1) Dong Nyung Lee and Young Ku Yoon,

"Fabrication and Evaluation of Tantalum Solid Electrolytic Capacitors," KIST R & D Report No. CE88-200; J. Korean Inst. Metals, 10 (1972) in press.

(2) Dong Nyung Lee and Young Ku Yoon,

"Frequency Characteristics of Anodic Oxide Films," J. Electrochem. Soc. (in press).

(3) Dong Nyung Lee,

"Self-diffusion in Sintering of Non-spherical Metallic Particles," Presented to The Third International Conference on Sintering and Related Phenomena at Univ. of Notre Dame, June 1972.

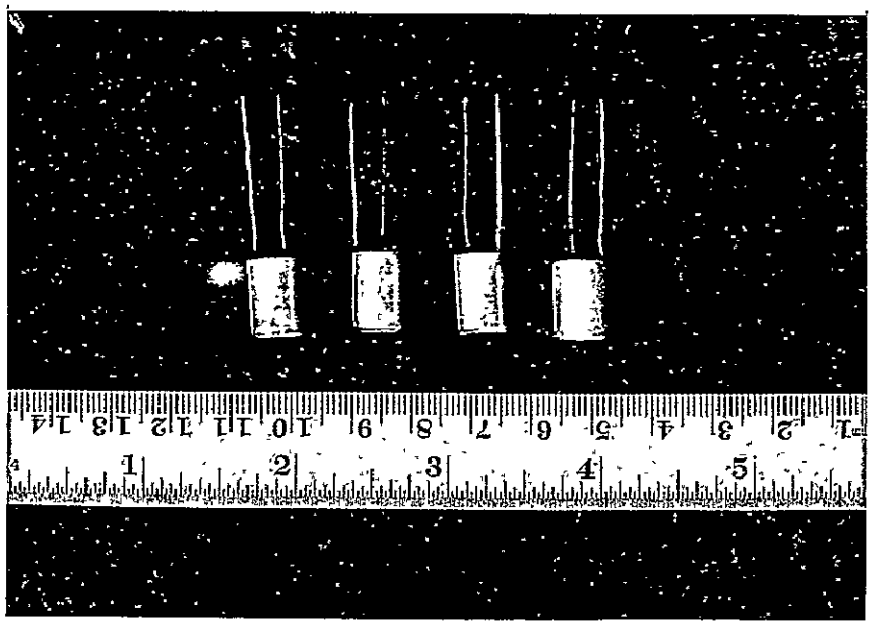

Fig. 23. Photograph of samples of tantalum solid electrolytic capacitors fabricated at KIST.

IMPLEMENTATION STRATEGY

Work will be continued on tantalum foil electrolytic capacitors during 1972. Parallel development of quality control and reliability engineering techniques will be conducted. After completion of the applications engineering and development work, a thorough joint study of the economic feasibility of domestic tantalum capacitor production will be proposed to three manufacturers of electronic parts, Tai-Han Electric Wire Co., Ltd., Samsung Electronics Co., Ltd. and Sam-Wha Condenser Industry Co., Ltd. When the feasibility warrants its manufacturing enterprise, KIST will assist an industrial sponsor, selected from among these three concerns, in establishing production facilities and procedures, and in training technical personnel.

PRESENT STATUS OF IMPLEMENTATION

The three manufacturers of electronic parts have been contacted on the possibility of transfer of tantalum capacitors technology. All the three have indicated their interest in conducting an economic feasibility study.

Major domestic applications for tantalum solid electrolytic capacitors at present are in electronic calculators (desk and pocket type) and in military communication equipment. Min-Sung Electronics Co., Ltd. plans to manufacture annually about 200,000 pocket-type electronic calculators, which will require 800,000 tantalum capacitors. Tai-Han Electric Wire Co., Ltd. and Dong Nam Electric Co. will produce about 10,000 electronic desk calculators this year, which will require 100,000 tantalum capacitors. The military demand for tantalum capacitors to be used in communication equipment is estimated at 150,000 units annually. The Korean military requirements for communication equipment, however, are presently met by a U.S. military assistance program. Although the time is ripe for entering the tantalum capacitor industry, the Korean industrial concerns want to wait and watch for a while.

CONCLUSIONS AND RECOMMENDATIONS

KIST has sponsored an R and D project whose object was to establish procedures for fabricating and evaluating tantalum solid electrolytic capacitors. KIST continues to sponsor an R and D project on tantalum foil capacitors this year. KIST is ready to transfer to the Korean industry the technology of tantalum solid electrolytic capacitors.

Three Korean makers of electronic parts (Tai-Han Electric Wire Co., Sam-Sung Electronics Co. & Sam-Wha Condenser Industry Co.) have indicated their interest in entering the tantalum capacitor industry. They want to wait, however, until the domestic market, estimated at one million dollars annually, becomes more certain.

APPENDIX H

STATUS OF THE LIMITED FOLLOW-UP PROBLEMS

The present status of each of the five problems selected for limited follow-up and monitoring are presented in this appendix.

CE-1 ELIMINATION OF CARBON MONOXIDE IN ANTHRACITE COAL BURNING

In 1971, KIST undertook a gas mask project which was closely related to this topic. Prospect of implementing this technology is good if an inexpensive, fail-safe method can be developed. Since no inexpensive method is in sight for the given topic, the best alternative is to utilize the information obtained to develop a catalyst for industrial and military purposes.

EE-16 CONSTRUCTION OF AUTOMATIC PICTURE TRANSMISSION GROUND EQUIPMENT FOR WEATHER SATELLITE PICTURE RECEIVING STATIONS

A significant accomplishment has come about as a result of meetings between KIST and the ROK Central Office of Meteorology: it has been decided to establish a weather satellite picture receiving station utilizing ground equipment modified by KIST. The Central Office of Meteorology will provide the necessary funds for the project, estimated by KIST at $12,000. KIST specialists have studied the NASA reports describing the inexpensive construction of satellite picture receiving stations, and have requested a technical appraisal of the project and a detailed cost estimate for the necessary parts and supplies for constructing and maintaining a unit.

Representatives of the Goddard Space Flight Center have provided KIST with much additional information concerning the weather satellite picture receiving station. They have recommended that KIST purchase a commercially available system. (The EMR Aerospace Science Corporation, which was the original Goddard contractor in this area, is currently manufacturing such satellite receiving systems under NASA authorization.) KIST has decided to carry out the project by purchasing the available hardware and improving a part of the system through introduction of solid-state circuits. The project will be completed by December, 1972.

FT-1 AN ECONOMICAL RETORT POUCH FOR USE AS A "FLEXIBLE CAN"

This problem has begun to move ahead and transfer activities are being increased. The purpose of the problem was to identify packaging materials and techniques which could be used to replace standard tin cans for many foods packaged in Korea. Evaluation of the information obtained in the literature search has led to the identification of a new packaging material which would be useful to the Korean food industry. Rights to this technology belong to Continental Can Company, and IITRI has conducted preliminary inquiries about obtaining a license and has sent KIST trial samples of the retort pouch.

Efforts have been made to contact two Korean industrial firms; one is cannery and the other is a flexible-package manufacturing firm. Although they are very interested in this technology, it appears that a lead time is essential before they can make final decision as to licensing of the technology.

This pouch has been tested at KIST for packaging a typical acidic fermented vegetable food. The preliminary observation strongly indicates that the pouch is quite satisfactory for the intended purpose. More laboratory work is required to identify the right kinds of Korean foodstuffs to be contained in this pouch. At present the pouch's applicability to both military and commercial packaging uses is being studied while contacts with the industrial firms are being maintained.

FT-5 ALL-PURPOSE SURVIVAL RATIONS

The literature searches revealed the availability of a substantial amount of information concerning new food developments and survival rations. Evaluation of the data showed that the available technology concerned not so much the actual products as the concepts and processing methodologies, some of which might be useful and applicable to Korean foods. The information obtained from the literature searches and the visit to the Natick Army Laboratories is currently being applied in development of combat rations for Korean Army. When the laboratory work currently in progress at KIST has been successfully completed, this technology is expected to be applicable for practical uses.

MM-7 EXPLOSIVE METALWORKING OF MILD STEEL

It is believed that explosive metalforming has the following advantages for a developing country like Korea:

(1) The explosive energy is self-contained, cheap, and in many special applications can be portable.

(2) Only a simple, inexpensive capital facility is required.

On the basis of these advantages, several Korean industries have been contacted to determine their interests as well as the possible products that might be formed by explosive method.

As a result of this brief survey it is felt that the establishment of pilot facility would not only demonstrate the effectiveness of explosive metalforming technology to Korean industry, but would lead in the creation of a demand for utilization of the technology. It is further believed that the facility could become a source of supply for a boiler manufacturer who is currently interested in forming domes by the explosive method. The facility is not cost effective at the present time but could become so within the next few years.