191064

China Report

SCIENCE AND TECHNOLOGY

19981021 079

DTIC QUALITY INSPECTED 3

FBIS FOREIGN BROADCAST INFORMATION SERVIC

4
127
A07

NOTE

JPRS publications contain information primarily from foreign
newspapers, periodicals and books, but also from news agency
transmissions and broadcasts. Materials from foreign-language
sources are translated; those from English-language sources
are transcribed or reprinted, with the original phrasing and
other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets
[] are supplied by JPRS. Processing indicators such as [Text]
or [Excerpt] in the first line of each item, or following the
last line of a brief, indicate how the original information was
processed. Where no processing indicator is given, the infor-
mation was summarized or extracted.

Unfamiliar names rendered phonetically or transliterated are
enclosed in parentheses. Words or names preceded by a ques-
tion mark and enclosed in parentheses were not clear in the
original but have been supplied as appropriate in context.
Other unattributed parenthetical notes within the body of an
item originate with the source. Times within items are as
given by source.

The contents of this publication in no way represent the poli-
cies, views or attitudes of the U.S. Government.

PROCUREMENT OF PUBLICATIONS

JPRS publications may be ordered from the National Technical
Information Service, Springfield, Virginia 22161. In order-
ing, it is recommended that the JPRS number, title, date and
author, if applicable, of publication be cited.

Current JPRS publications are announced in Government Reports
Announcements issued semi-monthly by the National Technical
Information Service, and are listed in the Monthly Catalog of
U.S. Government Publications issued by the Superintendent of
Documents, U.S. Government Printing Office, Washington, D.C.
20402.

Correspondence pertaining to matters other than procurement
may be addressed to Joint Publications Research Service,
1000 North Glebe Road, Arlington, Virginia 22201.

JPRS-CST-86-019

19 MAY 1986

CHINA REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

PEOPLE'S REPUBLIC OF CHINA

NATIONAL DEVELOPMENTS

ABSTRACTS

APPLIED ACOUSTICS

/12223

DALIAN'S TECHNOLOGICAL IMPORTS PAY OFF

Beijing RENMIN RIBAO in Chinese 30 Dec 85 p 1

[Article by Yan Xichen [3508 1119 2525]: "Dalian's Drive To Import and Assimilate Technology"]

[Text] Measures introduced by Dalian to import advanced technology and encourage enterprises to absorb and assimilate it have produced satisfactory results.

Since 1979, the municipality has imported almost 400 pieces of technological equipment to modernize its enterprises, of these 180 pieces have been completed and put into production so far. Through concerted efforts by the factories, scientific research units and colleges and universities concerned under the joint direction of the municipality, 76 projects have been absorbed, assimilated and popularized to varying degrees. Of the 380 new products developed by Dalian, about half reach or approach the technical standards of similar foreign products, and fill a technical vacuum in the nation.

Essentially Dalian absorbs and assimilates imported technology in the following ways:

First, joint production. By importing a complete set of technological equipment, enterprises have been able to come up with new products within a short period of time. This method made it possible for Dalian Heavy Machinery Plant to develop, little by little, in just a short time a small-scale continuous casting system up to a standard comparable to that of its international counterparts. Other factories concerned have successfully trial-manufactured over 80 large-scale new products like a diesel engine for low-speed ships, oil-drilling platforms, revolving hanging cranes and a bimetal hydrophobic valve.

Second, use imported prototypes as a model, and innovate; the idea being to surpass the original. Starting with a few relatively simple products and then moving on to more sophisticated ones, Dalian has absorbed the technology and models it imported and created new products out of them. This process requires little capital and produces good and speedy results.

Third, take the good points of imported equipment and use them to remedy the shortcomings in existing facilities.

Fourth, import only key technology and develop our own software.

In organizing the absorption and assimilation of imported technology, Dalian has taken pains to coordinate the relations between units which import technology and others which manufacture parts and components. When the project in question is complex and involves several units, the authorities concerned bring together every interested party to tackle it jointly. To support the absorption and assimilation of imported technology, Dalian has formulated a set of policies relating to tax, loans, prices and incentives. In terms of management, the municipality has implemented a contracting system and economic contracting responsibility system to make sure that projects which have been assimilated are really put to use. These measures have given the assimilation of imported technology a powerful push.

12581
CSO: 4006/670

TECHNOLOGICAL EXPORTS, IMPORTS DISCUSSED

[Article by Huang Zhiping [7806 1807 1627]: "Ways of Increasing China's Technological Exports]

[Text] In order to speed up our four modernizations, the import of advanced and applicable technology from abroad has become a strategic measure in our economic work. In recent years, we have had an initial breakthrough in this area. But another issue equally worthy of examination is how to aggressively increase our technological exports even as we step up our technological imports. There is a wealth of foreign experience here which we should draw upon. This article explores a number of related issues.

China's Technological Strength

Mention technological exports and some comrades would ask, "Our scientific and technological level is not high and our inventions and innovations are no match for those of foreign nations in either number or quality. Do we really have exportable technology?" The answer is yes.

The truth is that in some technological areas, we are still in a strong position. Over the past few years we have begun exporting quite a number of new designs and a fair amount of new technology even as we were heavily importing advanced foreign technology. For instance, we have exported the design and manufacturing technique of the plate heat exchanger to the Federal Republic of Germany [FRG], the design and manufacturing technique of blast furnace coal powder to Britain and top burning blast furnace technology to Luxembourg. Qinghua University has sold to Fujitsu, Ltd, Japan's largest computer company, the computer software it has developed for large and medium-sized computers. The Japan Electric Co recently purchased from us computer software for industrial use. Then there was the transfer to Sweden of a new welding system developed by Professor Pan Jiluan [3382 7139 7019] of Qinghua University, the purchase by two United States companies of rice crossbreeding technology from China Seed Co, and the sale to Japan of Beijing Food Research Institute's soya yogurt technology (including bacterial cultivation, equipment and technology). Most of these technological exports are among the best in their fields and many of them are of international standard. The Japanese have recognized our computer software exports as of "an extremely high

standard." After our rice crossbreeding technology was exported, 14 countries in different climatic regions are currently trying out our rice seeds, with remarkable increases in yields in most cases. (In the U.S., the new seeds increase output by 50 percent over local varieties.)

In plant exports, too, China's progress in recent years has been rapid. According to incomplete data, we have sold over 100 small-scale hydroelectric power stations to a dozen countries including the U.S., Canada, Peru, Colombia and the Philippines. We have exported to Thailand more than 1,000 pieces of textile machinery and sold to Pakistan a plate glass plant with an annual output of 12,000 tons, and bicycle tire production technology and equipment.

To be sure, our technological exports make up only a tiny share of the world's total technological trade and lag far behind our own technological imports both in scale and quantity. Nevertheless, the fact remains that in the midst of intense competition in the international technological market, we have our own strength and are capable of exporting technologies even as we are importing technology heavily.

China Has The Potential To Export Technology

A big country, China already has a very comprehensive industrial structure and a considerable scientific research capacity and is engaging in a broad range of production. From 1979 through 1983, there was a total of 17,990 major scientific research achievements nationwide, or 3,000 per year, including 632 nationally approved inventions or innovations. Of the 19 Chinese exhibits at the International Invention Exhibition in Geneva, 11 were awarded the invention prize. If we succeed in assimilating, absorbing, developing and modernizing what we have imported, and, in the process, "domesticate" it, the resultant new technology will constitute a tremendous potential export. Then there are our many superb traditional technologies and skills, such as ceramics, arts and crafts, secret Chinese medicinal prescriptions, northern and southern cooking, ancient calligraphy and painting, and the ancient technology of wallpapering with calligraphy or paintings, which should be highly competitive and able to carve out a special niche for themselves in the international market.

The establishment of a patent system in China will be a powerful boost to innovation, invention and technological progress. In little over a month after the law went into effect, the Chinese Patent Bureau has already received more than 4,700 patent applications. Since the patent system legally safeguards an investor's or enterprise's interests, it should significantly unleash and mobilize people's inventiveness, constitute a long-term, effective driving force behind technological advance and provide a fruitful source of technological exports.

It should be noted that China's intellectual products of industrial value such as scientific and technological know-how, scientific research achievements and arts and crafts have begun to make their way into the international technological market. According to incomplete statistics, there are over 1,000 large- and medium-sized scientific and technological development and exchange centers across the nation. In addition, a nationwide cooperative

network has come into existence. Large- and medium-sized cities like Beijing, Tianjin and Shanghai have already set up a regular technological market. Seventy eight trade delegations attended the first national technological achievements trade fair held in Beijing recently, exhibiting 15,000 new technologies. Reportedly the national fair will be held annually in Beijing from now on, and, starting with the next fair, efforts will be made to attract foreign participation. By combining the import and export of technology, the fair is slated to become an international technological market, clearly a positive and effective influence on the development of technological exports.

The above situation shows that we have an immense technological export potential. If only we seriously develop it, our technological exports have a bright future.

Suggestions For Developing China's Technological Export Trade

1. To develop technological export work, we must begin by raising our understanding, doing a good job in managing technological and scientific research achievements and getting more people to know the patent system. The economic value of an invention derives from its originality as well as its own innovativeness and practicality. Once the world is made privy to it, it becomes public property and may not be sold abroad or patented. For many years, because of our failure to regard technological achievements as a commodity or because some comrades unduly underestimated our own capabilities and considered our technology totally inferior to foreigners', along with the absence of a Chinese patent system and the lack of patent knowledge, we wittingly or otherwise made known to the world without compensation many valuable things, to the benefit of other nations. The techniques of making Xuan paper, a top-quality paper native to Anhui Province, Beijing's cloisonne technology, Rongbao zhai ancient painting reproduction and so on have successively been let out to the world. China's rice crossbreeding technology could not be patented abroad after it lost its originality as a result of having been published in international newspapers and journals. There must be effective management of new technology, traditional arts and crafts and prescriptions. In some cases, applications may be made for a patent so that the technology concerned can be used abroad under a patent or a license system. In other cases, the technology may be transferred as know-how under a license system.

2. Clear up technological export channels. At a time of explosive technological developments, if we fail to market transferable technology aggressively, it will soon become dated. Even patented technology may lose its market. Each year China has a host of scientific research achievements. If we can select some in time for overseas transfer, we can avoid losing our legitimate rights and interests. In fact, however, there are instances where some technologies could not find a buyer and were left to gather dust because of blocked sales channels. China is a vast country where access to information is limited. Thus there is a need for technological development service companies to disseminate innovations and inventions across the country and gradually open up our technological market to the world. Other channels may also be used, e.g., establishing ties with some foreign trade organizations, designating China's trade missions abroad as agents, and

participating systematically in certain overseas technological exchange exhibitions. Advertisements and other publicity announcements in our foreign economic publications may also help; reportedly the deal on Beijing's soya yogurt was struck after it was publicized in ZHONGGUO SHICHANG.

3. Formulate policies which encourage technological exports. To develop technological exports, we must begin by building up a legal system which helps promote such exports. We have promulgated the "Patent Law" and departments concerned are in the process of drawing up other relevant regulations. But in addition we must work out policies which encourage technological exports. India, for instance, has a provision in its technological policy which specifically emphasizes that the country "must develop internationally competitive technologies, especially those with export potential." The Argentine government has devised specific measures to encourage technological exports, e.g., offering loans of a subsidy nature and lowering export taxes.

4. Absorb, assimilate and improve upon imported advanced technology to domesticate it for re-export. If we can bring together technological imports and scientific research institutions, we may make new technologies even more sophisticated and resell them. Japan is a success story in this respect. Building upon furnace steel-smelting technology imported from Austria and the FRG, it came up with its derivative, smoke-and-gas recovery technique, which it has exported to Austria, the United States and the FRG. After assimilating nylon technology imported from the United States, it successfully created the tire thread technology which it is now reselling to the U.S. In this way Japan manages to increase its technological exports continuously. Technological exports by Shinnippon Steel Corporation alone have exceeded 2 billion Yen, several times what it spends to import technology.

5. Strengthen cooperation with the Third World to diversify technological exports. In the long run, the huge Third World market may become the chief customer of our technological exports. For a long time to come, Third World countries will remain heavy buyers of foreign technology. Since China is also part of the Third World and has a lot in common with them economically and technologically, our technologies should prove more acceptable to them. We also have decades of experience in foreign aid. As we go about developing our license trade from now on, we should pay attention to plant exports (engineering projects), provide engineering design, technical consultation and technical services, and organize joint ventures and wholly owned enterprises, among other things. An effort should also be made to see that our technological exports serve as an impetus to electrical machinery exports.

5. Firmly abide by the principle of speaking with one voice abroad and unifying management. Right now it is a case of everybody doing his own thing in technological export work. Since the export of technology involves knowledge in various fields, including technology, trade and law, and is something of a first for us, we must put a particular agency in overall charge to provide us with policy guidance and operational assistance. Only thus will technological export work develop healthily and successfully.

12581
CSO: 4006/172

ISSUES RELATING TO TECHNOLOGICAL STANDARDS DISCUSSED

[Article by Yuan Suohong [5913 6956 7703]: "The Importance of Importing Technological Standards"]

[Excerpt]   1.   Combining Imported Technological Standards and Domestic Standards

The purpose of importing technological standards is to raise our own scientific and technological standards. On the one hand, we must try to avoid duplication.   On the other hand, we must speed up our assimilation, mastery and application of foreign technological standards.   Even more important, we should take actual domestic technological standards as our point of reference; whenever we can make a piece of equipment which matches or approaches the international standard, we should not import; when our own product falls short of international standard and when the hardware in question is desperately needed, we must import in a timely way.   Once imported, the equipment should be promptly compared to the domestic counterpart, examined, assimilated and applied.   Only thus can we accelerate the pace of domesticating advanced foreign technological standards and raise our own standards.   The Shanghai Television Tuner Factory is one of those model units which has done a fine job combining imported technological standards with domestic ones.   In 1979, it imported from Japan an electronic tuner technology production line and 2 VHF, UHF automated tuner production lines.   To economize on foreign exchange, the factory was anxious to combine imported technological standards and domestic standards and decided to import only essential parts of the production lines, a move which saved more than half of what it would have cost had it bought the whole piece of equipment.   Whenever a piece of domestic equipment meets the processing technological standards, the factory invariably opts for the native product.   In addition, it makes it a rule not to import more than one set of any one kind of equipment.   At one point the factory needed two rivet busters for its production line.   Despite the lower domestic technological standards at the time and manufacturing difficulties, the factory, in its eagerness to speed up the domestication of imported technological standards, decided to import only one buster.   Through the scientific research method of "reverse engineering," moreover, it carried out tests, analyses and research and finally succeeded in making a buster by domesticating foreign technology.   In this way it solved the problem of equipment shortages and quickened the pace

of domesticating imported technological standards as well as saving foreign exchange.

2. The Importation Of Technological Standards Should Be Integrated With the Popularization of Technological Standards

The import of technological standards should be considered from every angle over and over again by the departments concerned. It should be included in the national, ministerial, regional or local comprehensive technological standards plan so that it is integrated with the popularization of domestic scientific research standards achievements and will produce greater economic results. Accordingly we must precede technological import work with good consulting work, including demonstrations, regarding the import of technological standards and domestic standards. There should be feasibility studies on technological standards and integrated plans with provisions for scientific research, production, application and popularization. After a piece of technology is imported, we should thus be able to come to grips with technological standards problems concerned and assimilate and apply it. Only on this basis can our people improve upon imported technological standards and speed up the "domestication" of such standards.

The basic purpose of importing technology is to promote technological and economic developments. The import of each and every piece of technology or equipment must be combined with the popularization of domestic technological standards. This is the only way to inject vitality into our work. To bring about such a combination in earnest, we must lay down concrete methods and measures governing the popularization, transfer and patenting of technological standards in the post-import stage, such being the only way to integrate meaningfully the importation of technological standards and equipment standards, on the one hand, with the transfer of technological standards achievements, on the other. The Shanghai Printing and Dyeing Machinery Plant, for example, popularizes imported technological standards even as it imports relevant technology and equipment. As a result, it created 18 new products of 11 different kinds in 1982 alone, contributing to the development of China's printing and dyeing industry.

3. The Import of Technological Standards Should Go Hand In Hand With Standards Management

The synchronization of the import of technological standards with the development of standards management helps promote the assimilation and understanding of imported technological standards so that they can contribute economically to our production as soon as possible. They are actually the two sides of a coin, complementary and closely related. A piece of technology or equipment or an assembly line may be state-of-the-art, but if nobody assimilates, masters, applies and manages its technological standard, it will not do any real good. An enterprise which lacks highly skilled professionals specializing in technological standards will not be able to carry out manufacturing in accordance with standardized procedures, and the result will be disastrous. Take the Shanghai No 1 TV Factory, for instance, which a few years ago imported from Japan a color TV assembly production line. Because it took pains to combine the import of technological standards with management,

promoted staff training, compiled and translated materials on technological standards, laid down operational procedures, managed technological standards and so on, the import produced impressive economic results. According to statistics, the factory turned out 310,000 black-and-white and color TV sets in the first 10 months of 1983, up 31 percent over the same period a year ago, and increased profits by 39 percent. Its total taxable profit exceeded 40 million yuan, more than its combined investments in technological imports and certainly enough to cover the cost of a color TV assembly production line.

4. The Domestication Of Imported Materials And Spare Parts Standards

The domestication of imported materials and spare parts standards is an important part of the assimilation work in China's technological import. It has a direct impact on maximizing the economic results of imported technology, on the speed of domesticating imported technology, and on the pace at which product quality is improved and products upgraded. In recent years, many Chinese enterprises have done a good deal of work to domesticate the standards of imported materials and spare parts and achieved notable economic results. A typical example is the Shanghai Light Bulb Factory.

From the very day it imported from Japan a production line to make 12- and 14-inch black-and-white kinescopes, the factory strived to assimilate and adapt to domestic use advanced foreign technological standards and gradually began to substitute imported raw and processed materials, dies, tools and spare parts with standard domestic products. So far it has succeeded in making as many as 452 die spare parts which otherwise would have to be imported. It can now make 25 of its 29 kinescope dies and manufacture most of the parts which go into the remaining 4. As for equipment spare parts, more than 2,000 items are designed and made by the factory. In the case of machine spare parts, in particular, over 90 percent are now domestically made. Turning to materials standards, of the 103 materials required in kinescope manufacturing, 69 were manufactured locally in 1984 as a result of the factory's effort. Last year's import substitution rate reached a high 73 percent. In less than 3 years the factory produced 2.8 million 12- and 14-inch kinescopes, and earned a taxable income of 77 million yuan, three times what it cost the factory to import the assembly line. Its economic results are the highest among similar imported production lines in the nation.

5. The Checking And Accepting Of The Technical Standards Of Imported Equipment

The checking and accepting of technical standards include important equipment standards, the functional standards stipulated in technical manuals and technological standards, etc. When standards problems are discovered during checking, we must demand compensation from foreign factories; otherwise the state will suffer heavy economic losses as a result of equipment not operating properly. One factory, for instance, imported from Japan a fluorescent lamp assembly line, but because it overlooked to examine the machinery, it was taken in by the Japanese. The obsolete assembly line was put into production and caused serious environmental pollution. It was a profound lesson for the plant. In contrast, Baoshan Iron and Steel Works tested the 46 sulfur fluoride high voltage combination motors it purchased from Tokyo Shibaura Electric Co, Ltd of Japan and discovered the so-called "best products" were

second-rate in terms of technological standards. A total of 12 major problems involving technological quality were identified. Following negotiations, not only were the 46 sets of equipment shipped back to Japan for repairs, but 15 Chinese personnel were also sent to Japan at the Japanese company's expense to supervise the repairs and ensure their technological standard. The Japanese also paid out $570,000 to cover the wages of Chinese inspection staff, the rent of the inspection site and the costs of inspection tools, etc. We can thus see the tremendous importance of inspecting the technological standards of imported technology and equipment before acceptance.

6. The Need For Legal Provisions On The Technological Standards Of Imported Equipment

To ensure we make full economic use of imported technology and equipment, the State Council has approved and put into effect a draft law, "Inspection and Control Procedures for Imported Technology and Equipment (Provisional)," worked out jointly by the departments concerned under the State Council and by the State Standards Bureau. This move provides a reliable guarantee for the development of technological standards work which is part of the overall task of speeding up the import of technology. Accordingly we should be fully aware of the important role of the draft law in the standards work of technological imports in the future.

12581
CSO: 4006/172

COMMENTARY CALLS FOR OPENING OF TECHNOLOGY MARKETS IN 1986

Tianjin JISHU SHICHANG BAO in Chinese 31 Dec 85 p 1

[Commentary: "Further Open Technology Markets To Welcome 1986"]

[Text] The entire country is excited to welcome a great 1986 which also corresponds to the implementation of the Seventh 5-year Plan. Tomorrow is the first day of the Seventh 5-year Plan. From this point on, the reform of the economic, scientific, and education systems in China will make steady progress to enter a key era of socialist construction. Technical personnel with ideals and ambitions are getting ready to fight for future goals. As we look back on the past and forward into the future, everything is full of life and everyone is spiritually exciting.

During the Sixth 5-year Plan, the annual increase in gross product, national income and national productivity is around 10 percent. Things are encouraging along the front of science and technology. Since Deng Xiaoping made the famous remarks that "science and technology is productivity" and "the intellectual in China have already become a part of the labor class" in the 1978 National Science Conference, the Communist Party of China and the whole nation has required a new understanding on the importance of science and technology, as well as technical personnel, in the four modernizations. Based on the great policy that "economic construction must depend on science and technology, and science and technology must face economic construction," the enthusiasm of the vast number of technical personnel has been motivated. During the Sixth 5-year Plan period, there were more than 10,000 technical accomplishments and many had significant economic impact after they were put into production. This spring, the CPC Central Committee issued a decision concerning the restructure of the scientific research system to initiate this reform. The commercialization of research accomplishments and the expanding of technology markets are the breakthroughs sought after by the reform. In merely several months, various types of multi-layer, multi-channel technology markets emerged across China. Numerous technical accomplishments and "short-term, easy and fast" technical projects are flowing toward industries and rural areas through these technical markets to bring prosperity to cities and villages. It also brings vitality to research institutions and universities. Technical market has become a pivot and bridge to bring new technology to production in the economy.

The great Seventh 5-year Plan is here. Science and technology is facing more difficult tasks. The Central Committee required us to implement thoroughly the policy of "dependence" and "orientation" and to turn this policy into real action in research and production departments. Restructuring the scientific research system to make it compatible with the reformed economic system will definitely proceed ahead. Based on the new situation, the task in front of the pioneers of the technical market is to further stimulate the growth of the market. In order to promote further development in production and technology, technical information should be widely circulated and exchanged. Through various channels, we should lead technical trades to grow in a healthy manner. With regard to the prosperous technology markets, we should provide general guidance and formulate suitable control methods to allow this new creature to grow continuously to perfect itself to serve China.

12553/9869
CSO: 4008/2056

CHINA'S TECHNOLOGY MARKETS DEVELOPED AT RAPID PACE IN 1985

Tianjin JISHU SHICHANG BAO in Chinese 31 Dec 85 p 1

[Article: Rapid Development of China's Technology Markets in 1985"]

[Text] Editor's note: Technology markets developed very rapidly in 1985 in China. Multi-level, multi-channel technical trading activities of various forms are widely initiated. Many technical market control organizations were created. Trading activities began to become popular in cities and rural areas. Based on incomplete statistics, there were 56,000 transactions taking place in technology markets in the form of contracts in the past 2 years. Total amount of transaction reached 320 million yuan. Looking ahead into 1986, the prospect of technology markets is bright. It will make new contribution to the magnificent Seventh 5-year Plan.

Nineteen-eighty-five has been the year in which great development of technology markets took place. Technology market control organizations have already been essentially established at the provincial, municipal, and autonomous regional levels. County operated technology markets are opening up. Village run technology markets are also beginning to emerge. The entire country is dedicated to the establishment of technology markets, which is encouraging.

Technology Markets in Central Cities Move Steadily Ahead To Serve as Backbone in the Technology Trades

Technology markets in central cities in China had developed earlier and faster. They have geographical and technical advantages and should serve as the backbone for all technology markets across the country.

According to incomplete statistics, Tianjin has over 570 technical development and consulting firms with more than 70,000 employees. Among them, more than 400 are full time employees. These organizations are actively serving Tianjin's economic development. They provide services to medium-sized and small business to gain better economic and social benefits. For instance, Tianjin Technology and Talent Development Center held several country fairs in response to the needs of rural businesses which is welcomed by farmers. Tianjin Technical Economic Service Company held a citywide bidding meeting in which over 300 problems were resolved. It was favorably viewed by factories.

Since the latter half of 1984, Taiyuan has already established 102 technical development firms and consulting services with over 5,300 participants which corresponds to 8.8 percent of the technical personnel in natural science in the city. In the past year, they undertook 560 technical and economic development projects. The total amount transacted reached 83,580,000 yuan.

Heilongjiang province takes the central city effect seriously. It estabished technology markets in Harbin, Mudanjiang, and Jiamusi. From March to October 1985 alone, the province of Heilongjiang held 32 technical accomplishment trade shows and the amount transacted reached 820 million yuan.

County Technology Markets Begin To Form a Network To Promote Small Town Business

In 1985, the county technology market has been rapidly developed. Many countries have permanent technology markets to stimulate rural economy.

Among 12 countries (cities) in Shangrao, Shanxi, 11 of them already have permanent technology markets. There are 1984 technical development projects in which 23 projects involve the import and promotion of new technologies resulting in significant benefits. The total technical service fee is 77,800 yuan. The economic benefit created is 1.83 million yuan. For instance, the county of Guangfeng held country fairs for technology trade to support small town industries. The county of Yushan initiated technical contracting to promote advanced agricultural techniques with noticeable results.

Nine counties, including Pinglu, Hejin, Jishan and Jiangxian, in the vicinity of Yuancheng, Shanxi held a technology market trade show in 1985. The amount transacted reached 139,000 yuan. Wanrong county opened a "Radio Technical Shop" since 1 August. In a month, the store broadcast over 100 technical items. By September, 39 techniques were already adopted.

In Pingjing, Hunan, the technology market completed more than 20 trades in the past 2 years. The amount transacted reached over 5 million yuans. It is estimated that the annual technical appreciation can be more than 40 million yuan in the near future.

Small Towns Build Permanent Technology Markets To Deliver Technology and Information Directly to Farmers

As the trend develops, some small towns in China begin to operate technology markets. They are aiming at meeting the needs of the farmers. Science and technology will be delivered directly to the farmers. The market serves as the bridge through which science and technology will make the farmers rich.

Small town technical markets have been rapidly developed in Jiangxi. Many small towns operate permanent technical markets. They are short-handed but are operated with flexibility to help local farmers become better off. Mianchuan village and Dingshan village in Penge county built technology markets to serve the farmers directly. The technology market in Mainchuan combines science and technology with production and economy. It set up permanent service stations for agricultural technology, cultivation, and

small town industries as well as a technical training school for farmers to get part-time jobs in order to deliver science and technology to the farmers. They have already imported 26 technical development projects which directly brought in an additional 1 million yuan for the farmers. The technology market in Dingshan, at the same time as it imports new technology, also sells new superior species and better insecticides to the farmers to form a complete set of technology around improved variety--cultivation--disease and pest prevention.

12553/9869
CSO: 4008/2056

QUICK APPLICATION OF PATENTED INVENTIONS TO PRODUCTION URGED

Tianjin JISHU SHICHANG BAO in Chinese 31 Dec 85 pp 1, 4

[Article by Huang Kunhua [7806 0981 5478], Chief of the Patent Bureau of
People's Republic of China: "Patented Inventions Should Be Quickly Applied to
Production"]

[Text] The People's Republic of China began to implement its patent law on
1 April 1985. This important reform in economic and S&T systems received the
concern of leaders in the government and the Communist Party. It is supported
by various local and relevant departments and the response from all applicants
in the world is enthusiastic. Some preliminary achievements have been
obtained. As of 25 December, the Patent Bureau received 14,051 patent
applications. According to the patent law, patent applications are registered,
classified, and reviewed. Since 10 September, based on the sequence of filing,
the Patent Bureau has announced 632 patent applications as requested by
applicants. According to the law, after an application is announced, there is
a 3 month challenge period before authorization can be given. On 26 December,
the Patent Bureau of the People's Republic of China made 138 decisions out
of the 150 applications first announced on 10 September. It issued 40
invention patents, 60 new application patents, and 38 appearance design
patents. There are 111 domestic applications and 27 foreign ones.

In the first batch of announcements made on 10 September, 22 objections were
received. Twelve of those challenges were rendered legitimate and accepted.
They are currently under serious review. Copies of the challenges were sent
to the applicants for rebuttal. If the review proves a challenge to be
valid, then the application will be rejected. Otherwise, it will be granted a
patent. If someone finds that a patent should not have been granted after the
fact, it can no longer be challenged. Instead, it should be processed according
to the patent nullification procedure specified in the patent law; i.e. to
request the Patent Review Committee to invalidate the patent.

After a patent application of an invention is filed, reviewed, and granted by
the Patent Bureau, the patent assignee has the right to manufacture,
distribute, and use the patented products and methods. This right has a
limited life. It is 15 years for an invention and 5 years for a new model
or external design. It may be extended for another 3 years. This is a
special property right--industrial right, granted by the government according

to the law. It should be honored as other rights of ownership. Based on Section 14 of the patent law and according to the implementation of important inventions in national planning, unless the practicing organization pays a royalty as specified by the government, anyone else cannot manufacture, use, and sell patented products and methods without the consent of the assignees. Otherwise, it constitutes a patent infringement. If a patent infringement occurs, according to the patent law, the assignees or licensees may request the patent enforcement agency to take actions. They may also file suits with the court to stop the infringement and demand economic restoration. The law also specifies that if anyone falsifies other's patent, it is also punishable accordingly. In addition, those directly responsible will be prosecuted according to Section 127 of the Chinese Criminal Code. Through a series of legal processes such as filing, review, and patent right issuance, the government acknowledges the ownership of the invention by issuing a patent. Achievements resulting from the work of intelligence by the inventors and designers are legally protected to stimulate creativity.

For this reason, another important task is raised as we issue the first batch of patents. We must further strengthen the education of the concept of industrial ownership right. All manufacturing and applications organizations must be aware of the law, understand the law, and implement the law. Existing law must be obeyed rigorously. Any violation will be investigated. All patent infringement behaviors will be processed in a strict and timely manner. With regard to licensing agreements reached, contracts must be seriously followed regardless whether the patent assignees are Chinese or foreign. Their rights must be protected according to the Patent Law of People's Republic of China.

Among the first 143 patents issued, 74 are inventions made by Chinese organizations. Based on the patent law and the rules governing the implementation of the law, the organization should reward the inventors and designers after the patent is issued. After the patent is being put in practice, they should also be rewarded according to the range of applications and the economic benefit. This realizes the policy of the government and the Communist Party to respect knowledge and talent. In addition to moral encouragement, inventors and designers who make contribution to any technical progress should also be compensated economically. Their share should be higher if the range of applications of their invention is wider and the economic benefit is larger. It is reasonable to earn more money based on one's own ability to create a big fortune for the country. Every unit should rigorously implement the patent law and its related rules.

To obtain a patent is not the final objective for filing a patent application for an invention. The ultimate goal is to convert an invention to productivity to be used in the four modernizations. Patent assignees should be well prepared not to miss any opportunities to develop the technology. Various conduits, such as attending technical exchange meetings, entrusting consulting, development and service organizations and winning support from higher level departments, should be exploited to promote the application of the invention as soon as possible. The implementation of the patent law offers a bright prospect for the technical market in China. There will be

over 10,000 patent applications filed every year from all over the world. This creates a buyer's market for Chinese industries looking for technical reform as well as for new technology. There will be many choices. Because patents are the newest inventions in the world, they proved to bring significant socioeconomic benefits after their implementation. In some cases, we may even be highly competitive in the world. We wish the relevant departments can create the condition to provide a convenient mechanism to certify products, prepare product specifications, issue production permits, ensure the supply of raw materials and all necessary parts so that the new technology can be transformed into products to be widely used. Departments responsible for planning scientific research, technical reform and technology import should take inventions already under protection by the Chinese patent law into consideration to avoid duplications. Intelligent resources already developed and protected should fully be utilized. Applications already filed with the patent bureau are being reviewed. The bureau will issue a number of patents monthly. It is moving on the right track. We deeply appreciate the concern and support from all over the world for the establishment of a patent system in China. We hope to continue receiving such support in the future. The implementation of a patent law in China taps an important resource of intelligence. The spring of intelligence will converge at the Patent Bureau and then be purified before it flows to the rest of the country and the world. China is a nation with a long history of intelligence. Today, as the urban economic and technical systems are being reformed, we must be able to stimulate the creativity of the nation to write a new page in the history book in invention for the whole world.

12553/9869
CSO: 4008/2056

TIANJIN SUCCESSFUL IN COMBINING SCIENTIFIC RESEARCH, PRODUCTION

Tianjin JISHU SHICHANG BAO in Chinese 31 Dec 85 p 1

[Article: "Combining Scientific Research and Production Brings Significant Benefit in Tianjin - More than 110 Combined Entities Already Formed"]

[Text] Tianjin has attached importance to combining scientific research and production. At present, over 110 combined entities comprised of research, education and production units have been organized. More than a third of them are licensed economic entities with their own capitals and independent accounting systems. According to statistics gathered on eight such entities in light manufacturing, electronics and textile, the annual increase in productivity is worth over 50 million yuans and more than 10 million yuans in royalty can be raised.

A review of the development of combined research and production entities in Tianjin shows the following types and special features. Scientific research organizations, universities, and production facilities jointly establish a plant to develop new products by way of capital investment or technology partnership. Because the economic tie is very close, this type of collaboration is usually more aggressive. Therefore, product development and production are moving more rapidly and the economic benefit is also more significant. The second type is that research organizations, universities and manufacturing facilities from a contracting company to undertake large scale, mutli-disciplinary engineering projects. Because this type of combined entity gathers the most outstanding technology and people in various areas, the organization has the ability to undertake projects which cannot be done by one or several units alone. The third type is an organization formed by research outfits, universities and manufacturers to promote practical technology and research accomplishments. On a nationwide basis, it not only sells technology and equipment but also provides consulting services. The fourth type is an organization formed for technology reform and product renewal in a specific trade. The fifth type is that research outfits, universities and manufacturers get together to develop new products jointly. The sixth type is to tie a research unit to a production facility to make it become an internal development department. The facility thus becomes an economic entity with production as well as scientific research.

12553/9869
CSO: 4008/2056

EASTERN PROVINCES, CITY RESTRUCTURE SCIENTIFIC RESEARCH

Tianjin JISHU SHICHANG BAO in Chinese 31 Dec 85 p 1

[Article by Bo Mu [2672 2606]: "Scientific Commissions From Six Provinces and One City in Huandong Discuss Reform of Scientific Research System"]

[Text] Recently, members of scientific commissions from six provinces and one city in eastern China responsible for the reform of scientific system gathered to exchange information on the reform of various types of research organizations and to discuss problems encountered in the process.

Since last year, the reform of research organizations went along very well. According to statistics, there are 1,237 independent scientific research organizations above the city level in these six provinces and one city. A total of 369 are currently under reform, which corresponds to 32 percent. Eighty-nine of them can support themselves, which corresponds to 22.5 percent of those already restructured. City and provinces such as Shanghai, Anhui, Shandong and Jianshu stipulate that their support in operating expenses will be gradually reduced yearly by a fixed proportion starting from 1986. By 1990, these organizations will have to support themselves. Their analysis showed that it is possible for a technical development oriented organization to become self-sufficient in 3-5 years. Several comrades proposed that organizations capable of slashing operating expenses at faster rates should be favorably treated in distribution. We should avoid similar treatment across the board to penalize the faster movers.

In the meeting, Anhui province introduced 13 regulations regarding expanding the autonomy of research institutions. Under the premise of completing assignments given by the government, a research institute should have the right to adjust the direction of the assignment, the right to schedule research plan, and the right to transfer its own technical accomplishments. Everyone also considered that the important essence of the reform is to combine research with production in order to change the closed loop structure to an open structure. There are 436 combined entities in Anhui to date. The rate of growth is very fast; six times faster than the year before. The economic benefit is also significant. For instance, 40 combined entities in the city of Hefei completed more than 200 collaborative projects of high standards in the past 2 years and increased productivity by approximately 200 million yuan.

Various issues, such as the relation between government assignments and lateral contracts, the relation between income producing programs and medium- to long-range projects, linking bonus to operating cost reduction, and formulating specific duties of institute director and Communist Party secretary as well as rules and regulations to manage employees, were discussed. All comrades agreed that the experience acquired this year must be summarized to accelerate the reform of the scientific research system.

12553/9869
CSO: 4008/2056

COMMENTATOR URGES HELPING POOR AREAS WITH SCIENCE, TECHNOLOGY

OW271235 Beijing XINHUA Domestic Service in Chinese 0222 GMT 26 Apr 86

[Text] Beijing, 26 Apr (XINHUA)--Title: Strive to Write a New Chapter of Supporting the Poor Areas With Science and Technology

By XINHUA commentator

One major task listed in Document No 1, of 1986 of the central authorities is to earnestly help the poor areas to gradually change their backwardness.

Since the 3d Plenary Session of the 11th CPC Central Committee, China has made outstanding achievements in agriculture that have attracted worldwide atten⊖ tion. Most localities and the majority of peasants have been able to solve the problem of having enough to eat and wear and are advancing with big strides toward the goal of achieving prosperity. Nevertheless, because of disproportionately bad natural conditions and due to social and historical conditions, around 200 counties and several tens of millions of peasants across the country still have to break free from poverty. They are in urgent need of help.

In the past, our assistance to poor areas has been offered mainly in the form of money and supplies. While this method gives temporary relief to people short in food and clothing, it in no way improves the poor areas' ability to develop themselves. Consequently, in spite of the large funds spent in relief year after year, their poverty has not changed very much.

In recent years, many localities, after summing up experience, have tried and gradually found a new way to tackle the problem by helping poor areas with science and technology. That is, they combine the poor areas' superiority in resources with the application of science and technology. This approach brings instant and good results without much investment. Besides, it strongly moti- vates the poor areas to develop themselves. One example of success is found in Hebei, where the province and the State Science and Technology Commission joint- ly organized a technical development project for 10 poor counties in the Taihang Shan area. They applied science and technology to exploit the mountain area's resources. The project took only 7.1 million yuan in investment, but the econ- omic results yielded 270 million yuan. In a short span of only 4 years, the area's per capita income rose from 75 yuan in 1981 to more than 300 yuan in 1985. The wish of the people there to shake themselves free from poverty, a

wish that had remained unfulfilled for more than 30 years, has now been realized with the help of science and technology. When he inspected the area recently, Comrade Hu Yaobang noted that the most important support needed by poor households is the support of science and technology.

The introduction of science and technology to poor areas has made an enormous impact not only in the economic sector but also on the people's mentality. Under a project of Guizhou Province, four mountain counties were selected for comprehensive technical development and more than 50,000 of their peasants received training as a result. New scientific knowledge brought them out of a protracted mental state of closure and ignorance and opened wide vistas for them. At present, an open rural economy is taking shape and a new generation of peasants is at the same time growing up in these four countries.

Some people say: It is fine to use science and technology to support poor areas, but we don't have the necessary conditions in our area for such an undertaking. On the whole, it is true that China does not have adequate scientific and technological capability, especially in agricultural science and technology. However, it is also true that the following situation can be found in many provinces, including in quite a number of counties: on the one hand, they complain about a shortage of scientists and technicians; but on the other hand, many scientists and technicians are being stashed away in offices where they cannot put their knowledge and skills to use. On the one hand, many production projects cannot be carried out because of a lack of scientific and technological knowledge; but on the other hand, many agricultural science and technology research results are not being applied although they are quite applicable, high in economic results, and easy to be popularized. This shows that provided localities do a good job in organization, tap existing potentials, and use science and technology to help poor areas by stages and in groups, they can accomplish a great deal in this field.

It should be noted that supporting poor areas with science and technology is an endeavor that not only benefits the poor areas but also helps the development of science and technology. The scientists and technicians of the State Science and Technology Commission and Hebei Province who took part in the project to develop the Taihang Shan area, for instance, achieved over 40 research results, 16 of which attained the advanced national level.

More and more people now understand the importance of supporting poor areas with science and technology. At present, 27 provinces, municipalities, and autonomous regions have organized a total of more than 5,500 scientists and technicians and sent them to work in poor areas. It is our hope that all localities will write a new chapter of supporting poor areas with science and technology so that the spark of science and technology will start a still wider prairie fire in these poor areas.

/9274
CSO: 4008/2103

DEVELOPMENT OF REGULAR INSTITUTIONS OF HIGHER LEARNING DISCUSSED

[Article by Xian Liting [0752 4539 0080]: "Revolution in Higher Education"]

[Text] The period of the development of regular institutions of higher learning since the founding of the Peoples' Republic has been one of continuous development and uninterrupted growth and progress; yet we have also gone through a stage of blind development during which we lost sight of historical conditions, ignored the requirements of social and economic development, exceeded the powers of the state, and violated educational laws. We also experienced a "10-year period of confusion" during which we gravely underestimated the value of knowledge and human potential and during which we even questioned the value of opening institutions of higher learning. Experience tells us that if we are to promote the growth and prosperity of regular institutions of higher learning, we must use our national heritage as a starting point, adopt an empirical point of view firmly based on facts, and operate according to objective laws. We must deal correctly with the relation between necessity and feasibility, analyze the return on our investment, and strive for a balanced result within the scope of the entire nation. In the new historical period we must discard our mistaken habit of underestimating the value of knowledge and neglecting the cultivation of human potential while overvaluing material production; we must increase our investment and broaden the scale of our higher educational enterprise, maintaining and raising the quality of higher education. On the other hand, we must prevent the sort of blind development which we experienced in the past, seeking instead to develop only those phenomena which will restore order to the system. This article will examine some of these issues.

In looking at the situation in the establishment of institutions of higher learning in the past few years, we see that in 1976 the country had 392 regular institutions; by 1984 the number had junped to 902, a solid threefold increase. Presently, we are maintaining this momentum of rapid development. Based on preliminary data, the end of this year should see the number of regular institutions of higher learning reaching 1,000, an increase of about 100 over last year. Under these circumstances we must, while congratulating ourselves, keep a cool head about seeing the problems amidst the progress. In the development of institutions of higher learning

over the past few years, the primary contradiction has been that, on the one hand, the educational potential of existing institutions has not been fully tapped while, on the other hand, there is an ever-increasing number of new institutions, stretching and fragmenting a limited number of human, financial, and material resources. Several problems have surfaced in these newly established institutions. The first is a neglect of the task of forecasting the demand for educated manpower, a blindness which has resulted in the failure of a few institutions; the second is a one-sided emphasis on the demand for trained personnel while neglecting the essential preconditions for the running of schools, resulting in some schools' inability to develop their educational potential, even after being successfully established; the third is an irrational geographic placement of schools, resulting in a wasteful redundancy in some areas; the fourth is an obsession with a school's rank and prestige, while neglecting the importance of creating a rational system and a strategy for the cultivation of talent; and the fifth is a lack of progress toward the creation of an integrated balance on the national scale—a "small but complete" mentality.

These problems should be addressed not only in theory but also in practice. In developing our regular institutions of higher learning, especially when adding new institutions, we must pay attention to these three aspects: first, we must consider the principles underlying the establishment of new institutions; second, we must safeguard the essential preconditions for the running of schools; and third, we must operate in accordance with a system for examination and approval of new institutions.

First, let us talk about the underlying principles of establishing new institutions.

(1) Anticipating future demand for educated manpower and establishing a rational system for cultivating such manpower. Everybody knows that our regular institutions of higher learning shoulder the burden of training our nation's future professionals so that we not only can invest more time and money in this than in other projects but also can make sure that every new school is extraordinary and has attained a state-of-the-art condition. Having confirmed the importance of these characteristics, the building of a school must be a long and steady process, and the ultimate success or failure of the school will depend on the demand for its product. Every district and department must consider its own situation as a starting point for scientifically forecasting future demand for educated personnel, feeling out the requirements for the quality and quantity of personnel at every level of every field. Only then should they consider the necessity of establishing a new school or a new field of study. Then, after deciding on the level and scale of such a new school or field, they may proceed with an overall plan, avoiding blindness, for the establishment of a rational system for cultivating the needed personnel. Those who are not needed now should be developed to provide for the long-range needs of the country. Existing institutions of higher learning should add to their vocational training and broaden their enrollments to help solve the demand for educated personnel. With proper cultivation and the coordinated management of existing schools, we can satisfy the demand for personnel without needing to establish yet another new institution.

(2) Strengthening leadership and establishing a rational plan for the layout of the institution. For historical, economic, and operational reasons, our nation's institutions of higher learning are not rationally laid out. This is manifested mainly in three areas: the first is an unbalanced development among geographical areas; the second is a disproportion among fields of study; and the third is an unnecessary redundancy of establishments.

As far as geographical distribution is concerned, since the founding of the Peoples' Republic our frontier regions, ethnic regions, and internal provinces have all experienced a rapid growth in the establishment of new institutions of higher learning, while development has been rather slow in the coastal regions. In 1984, out of 902 higher institutions throughout the country, 418, or 46.3 percent were located in the 10 coastal provinces and cities of Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong; 192, or 21.2 percent, were located in the 10 provinces (autonomous regions) of Nei Monggol, Sichuan, Guizhou, Yunnan, Xizang, Shaanxi, Jiangsu, Ningxia, Qinghai, and Xinjiang; 292, or 32.5 percent, were located in the remaining 9 provinces (autonomous regions). Naturally, the reapportionment of institutions faces many obstacles and cannot be achieved overnight. But any middle- and long-range plans for the development of higher learning must include a strategy for changing this irrational distribution and promoting the development of higher education on the frontier and in certain ethnic territories and inner provinces.

As far as the disproportion in fields of study is concerned, in the 30 years since the founding of the republic, departments of science, engineering, and normal (teacher) education have experienced a rapid development, while finance, economics, and political-legal studies have developed slowly, resulting in an imbalance which is not responsive to the current needs of our economic and social development. The achievement of a more rational balance among fields of study not only is a major responsibility of the revolution in our educational system but is also a question of principle to be considered by newly established institutions of higher learning.

In recent years departments in all regions have taken a strong initiative in opening new schools, but because of insufficient cooperation there now appears to be a redundancy of establishments. This is wasteful to the nation as a whole. consequently, in the future we must look at the whole situation before establishing a new institution in order to eliminate this wasteful redundancy of establishments.

(3) Obtaining a return on our investment in new schools. On the whole, the return on our nation's investment in regular higher education has not been ideal, as manifested in our schools' smallness of scale and singularity of courses. According to statistics, in 1984, 902 regular institutions of higher learning throughout the country contained a total student population of 1,335,000, which averages out to 1,480 students per school. Among these, 111 schools had less than 300 students; 93 schools had 301-500 students; and 228 schools had 501-1,000 students. Obviously, the

smaller schools represent a large proportion of the total. As for the unitary system of courses, although there has recently been some improvement, there is still a universal problem of too little specialization and too small a variety of courses. These problems not only affect the quality of instruction and scientific research but also lower the return on our investment. Therefore, in establishing new institutions we must not only pay attention to the principles of scale and variety of courses but also regulate the numbers of students.

Now, let us talk about the essential preconditions for the running of schools.

Institutions of higher learning must cultivate a mutually supportive network of specialized personnel according to a definite set of specifications. All preconditions must conform to the school's mission, character, scale, etc. To overemphasize the demand for personnel while ignoring the preconditions for the running of schools is "first to mount the horse, then to prepare the saddle"; on the other hand, we must allow the school some leeway to complete the process of filling out and developing, without expecting too much in the way of conditions in the beginning. Among the many conditions which must be met in newly established schools, three areas are especially important. The first is the qualifications of teachers; the second is the school's premises, its laboratory and library facilities; and the third is the leadership group.

Newly established institutions of higher learning always have problems supplying qualified teachers. In the beginning, an eagerness to provide a number of teachers which matches the school's scale and standards, plus the fact that enrollment is small at first, causes some schools to waste manpower. Consequently, when it comes to the number of trachers, it is best to calculate according to the actual number of students. As for teacher quality, it is best to calculate according to the actual levels and abilities of the students, providing teachers of a certain standard who have experience teaching courses at levels which match those of the students. The requirements of schools of science may be slightly different, but all must guarantee educational quality by providing teachers of a set standard who rank at or above the level of a associate professorship.

The school's buildings, laboratory facilities, and library resources must be allowed to develop progressively over the years, but when the school is officially opened and is admitting students, these resources must meet the needs of the students for the academic year.

The leadership plays a decisive role in the success or failure of a school. Therefore we must follow the guidelines of the Central Committee and carefully select the governing bodies of schools: "Follow the principles of making the cadre ranks more revolutionary, younger in average age, better educated, and professionally more competent in selecting leaders."

Third, let us talk about the process of the examination and approval of new institutions of higher learning

Since the founding of the Peoples' Republic, the method of authorizing new institutions has basically conformed to the methods of administrative management: the proposal for a new institution rises from the lower levels of management through the upper administrative levels and finally reaches the authorities in charge of examination and approval. This type of management style is neither serious nor scientific enough and cannot help leading to mistaken procedures as well. As far as the process of approval is concerned, in addition to clarifying the functions of each administrative level, we must also set forth clear stipulations concerning the following three areas:

First, we must create a system for demonstrating both the necessity and the feasibility of establishing new schools. This means that all proposals for the establishment of new institutions of higher learning should undergo thoroughgoing discussions concerning the demand for personnel, the distribution of institutions, the return on investment, and the preconditions for the running of schools. Based on the four modernizations and our nation's educational enterprise as a whole, we need to formulate an overall plan which deals properly with the relationship between necessity and feasibility and the present and the future, and which will master the inefficiency brought about by a purely administrative bureaucracy.

Second, we should effect a system of double examination and approval for new institutions of higher learning. The first thing to do is to approve the plan for constructing, and the second is to authorize the official opening and admission of students. This method will help to preserve educational quality and will give unapproved schools some time to make the proper adjustments.

Finally, let us establish an appropriate examination and grading system.

In summary, the development of regular institutions of higher learning is a huge matter which not only influences the development of our entire educational enterprise but is also intimately related to the progress of the four modernizations. Only by drawing on our historical experience, holding fast to empirical methods, and taking up the spirit of the Central Committee's "Decision Concerning the Revolution in the Educational System," can our regular institutions of higher learning advance along the right track toward socialist modernization.

BRIEFS

OBSERVATORY OPTICAL EQUIPMENT, KNOW-HOW FROM DENMARK--Assistant Prof Johannes Andersen, institute director of Copenhagen University's observatories in Copenhagen and Brorfelde, near Holbaek, has travelled to China in order to give lectures. This is a further demonstration of the cooperation occurring now between Danish and Chinese researchers. The instrument factory in Nanjing is a glass meridian circle in accordance with instructions of Assistant Prof Erig Hog. A couple of years from now it will be mounted on the Shaanxi Observatory, located near the old capital Xian. It is an extremely accurate instrument for determining the locations and movements of heavenly bodies. The principle for its use was worked out 300 years ago by Ole Romer, a professor and chief of police in Copenhagen. Erik Hog has had a couple of Chinese working with him in Brorfelde, the astronomer Li Zhigang and the engineer Yao Zhen Qui. And now is coming the electronics specialist Xu Xinqui. /Text/ /Copenhagen BERLINGSKE TIDENDE in Danish 22 Apr 86 p 7/ 12228

CSO: 3613/109

PHYSICAL SCIENCES

METHODS FOR DESIGN OF CURVE MADE BY PAIR OF ROLLING CAMS

[Article by Ding Guanggui [1353 0342 2710] of Nankai University]

[Text] In some production and defense units people frequently want to employ
machinery with paired multithreaded gears. Moreover under certain conditions
it is also required that there be a constant relationship in the correspond-
ing angle of each of the curves of the outline of the cams which role on each
other. This article discusses design plans for the curves of a pair of roll-
ing cams with opposite central angles. Because this question is extremely
useful in actual production this preliminary article hopes to have the effect
of inciting more important results by instigating continued research by our
colleagues to come up with better design plans.

§0. A Method for Representation of Cam Curves in Polar Coordinates

Because of the requirements of actual problems, we need only to find the
characterization of the convexity for the segment of the curve in the first
quadrant. In addition, in the problems which we consider we want to be able
to represent the curves we seek in form of (functions of a single variable)
y = y(x) or x = x(y).

Suppose the curve in the first quadrant has the polar equation

$$r = r(\varphi) \left(0 \leqslant \varphi \leqslant \varphi_1, \ \varphi_1 \leqslant \frac{\pi}{2} \right),$$

then, when $0 \leqslant \varphi \leqslant \varphi_1$, and if we always have $r'(\varphi) \geqslant 0$ (or always $r'(\varphi) \leqslant 0$),
because of the right angle, the polar coordinate conversion relationships are

$$y'(\varphi) = [r(\varphi) \sin \varphi]' = r'(\varphi) \sin \varphi + r(\varphi) \cos \varphi > 0$$

$$(\text{or corresponding} \ x'(\varphi) = r'(\varphi) \cos \varphi - r(\varphi) \sin \varphi < 0),$$

$$0 \leqslant \varphi \leqslant \varphi_1 < \frac{\pi}{2},$$

with the result that the corresponding vertical y component (or horizontal x component) of the curve must be a monotonic increasing (or decreasing) segment of the function of the argument of $\varphi(0 \leqslant \varphi \leqslant \varphi_1)$. That is, any y value (or x value) on this segment of the curve cannot correspond to two x values (y values) so it must be possible to represent this segment of the curve in rectilinear equations of the form,

$$x = x(y) \qquad (y(0) \leqslant y \leqslant y(\varphi_1))$$
$$[\text{or } = y(x) \qquad (x(\varphi_1) \leqslant x \leqslant x(0))].$$

Moreover, from simple differentiation we can obtain

$$x''(y) = \frac{-[2r'^2(\varphi) + r^2(\varphi) - r(\varphi)r''(\varphi)]}{[r'(\varphi)\sin\varphi + r(\varphi)\cos\varphi]^3}$$
$$\left(\text{or } y''(x) = \frac{2r'^2(\varphi) + r^2(\varphi) - r(\varphi)r''(\varphi)}{[r'(\varphi)\cos\varphi - r(\varphi)\sin\varphi]^3}\right).$$

Consequently for this segment of the curve there exists the equivalence relationship

$$2r'^2(\varphi) + r^2(\varphi) - r(\varphi)r''(\varphi) > 0 \Longleftrightarrow x''(y) < 0 \quad (\text{or } y''(x) < 0). \tag{*}$$

This is to say, in the first quadrant, if with the radius vector of the curve segment $r(\varphi)$ we always have $r'(\varphi) \geqslant 0$ (or conversely $r'(\varphi) \leqslant 0$) then for this curve there is an equivalence between the "convexity" or $r(\varphi)$ in the sense of polar coordinates and "convex upward" of x(y) (or y(x)) with respect to the x (or y) axis and the (*) above is the characteristic form of this equivalence.

§1. Mathematically Abstract Description of the Problem
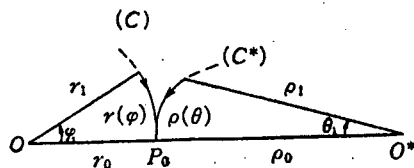
Figure 1

In Figure 1 let 0 and 0^* be the fixed centers of two convex wheels. Now we want a point P_0 on the line $\overline{00^*}$ (let $\overline{OP_0} = r_0$; $\overline{O^*P_0} = \rho_0$, $r_0 + \rho_0 = D_0$) and let the two smooth curve segments (C) and (C^*) be calculated so that when curve (C) rotates clockwise about 0, (C^*) rotates counterclockwise around 0^* and they always touch each other (rolling). In addition, the curves (C) and (C^*) are convex with respect to 0 and 0^*, respectively. When curve (C) has gone through angle φ_1 curve (C^*) has gone through the corresponding angle θ_1, the radius vector of (C) has gone from r_0 to r_1 (sometimes it might also be required that when the curve (C) begins the first and second order rates of change are to be given the initial values

31

r'_0, r''_0 and final values of r'_1, r''_1 to guarantee that the curve is "second order smooth" at the two crossover points.)

Below we provide the mathematical analysis required of this situation. First with 0 as pole and 00^* as polar axis in this polar coordinate system, we make the curve segment

$$(C): \quad r = r(\varphi) \quad (0 \leqslant \varphi \leqslant \varphi_1);$$

at the same time in a polar coordinate system with 0^* as the pole and 0^*0 as the polar axis (a lefthanded system where the argument increases in the clockwise direction) we make the curve segment

$$(C^*): \quad \rho = \rho(\theta) \quad (0 \leqslant \theta \leqslant \theta_1).$$

In this way the restrictions above can be written as

i) $\quad r(0) = r_0$, $\rho(0) = \rho_0$, $r_0 + \rho_0 = \overrightarrow{00^*} = D_0$ (distance between centers)

ii) the curves $r = r(\varphi)$ and $\rho = \rho(\theta)$ constantly touch each other as they turn and when φ has turned through the arc φ_1; θ has gone through θ_1;

iii) $r(\varphi_1) = r_1$;

iv) $r(\varphi)$ and $\rho(\theta)$ are both convex segments with respect to the polar centers 0 and 0^*, that is we have (from the form (*) in section §0)

$$C(r) = 2r'^2(\varphi) + r^2(\varphi) - r(\varphi)r''(\varphi) > 0 \quad (0 \leqslant \varphi \leqslant \varphi_1),$$
$$C(\rho) = 2\rho'^2(\theta) + \rho^2(\theta) - \rho(\theta)\rho''(\theta) > 0 \quad (0 \leqslant \theta \leqslant \theta_1).$$

(We might also have

v) $\quad r'(0) = r'_0$, $r''(0) = r''_0$,

vi) $\quad r'(\varphi_1) = r'_1$; $r''(\varphi_1) = r''_1$, etc.)

In order to facilitate the design of oppositely rolling convex curves outlined above we first make note of some relevant knowledge of meshing. From theoretical mechanics we know that if the two curves described above are to roll while in contact then their point of contact must remain on the line between their centers. Thus if we suppose

$$\theta = \theta(\varphi) \quad (0 \leqslant \varphi \leqslant \varphi_1)$$

then we have the relationship

$$\theta(0) = 0, \quad \theta(\varphi_1) = \theta_1$$

and

$$r(\varphi) + \rho(\theta(\varphi)) \equiv D_0 \quad (0 \leqslant \varphi \leqslant \varphi_1). \tag{1}$$

32

Consequently, taking the derivative with respect to φ we get

$$r'(\varphi) + \rho'(\theta)\frac{d\theta}{d\varphi} = 0 \quad (0 \leqslant \varphi \leqslant \varphi_1);$$

and in addition, at any point of contact, P, on the two revolving curve segments, because a common tangent exists, from the β relationship of "radial, tangential vector angle" we also have

$$\tan \beta = \frac{r(\varphi)}{r'(\varphi)} = -\operatorname{tg}(\pi - \beta) = -\frac{\rho(\theta)}{\rho'(\theta)} \quad (0 \leqslant \varphi \leqslant \varphi_1).$$

Thereupon by combining these two equations we can derive the differential quotient of the two rolling (meshing) curves $r(\varphi)$, $\rho(\theta)$ with respect to their arguments (in radians)

$$\frac{d\theta}{d\varphi} = \frac{r(\varphi)}{\rho(\theta(\varphi))} \quad (0 \leqslant \varphi \leqslant \varphi_1). \tag{2}$$

Now, from the above formula a design is at hand. Make

$$f(\varphi) = \frac{d\theta}{d\varphi} \quad (0 \leqslant \varphi \leqslant \varphi_1)$$

(In engineering sometimes this is called the "gear ratio" function.) then from (2) obviously we know $f(\varphi) > 0$ $(0 \leq \varphi \leq \varphi_1)$. From (1) and (2) we can derive

$$f(\varphi) = \frac{r(\varphi)}{D_0 - r(\varphi)} \quad (0 \leqslant \varphi \leqslant \varphi_1), \tag{2'}$$

and as a result we have

$$r(\varphi) = \frac{D_0 f(\varphi)}{1 + f(\varphi)} \quad (0 \leqslant \varphi \leqslant \varphi_1),$$

$$r'(\varphi) = \frac{D_0 f'(\varphi)}{[1 + f(\varphi)]^2},$$

$$r''(\varphi) = \frac{D_0}{[1 + f(\varphi)]^3}[(1 + f(\varphi))f''(\varphi) - 2f'^2(\varphi)]. \tag{3}$$

In this way, we can represent the condition of convexity of the curve $r(\varphi)$ using $f(\varphi)$ and its derivative function as

$$C(r) = \frac{D_0^2}{[1 + f(\varphi)]^3}[2f'^2(\varphi) + f^3(\varphi) + f^2(\varphi) - f(\varphi)f''(\varphi)] > 0$$

$$(0 \leqslant \varphi \leqslant \varphi_1). \tag{4}$$

33

Similarly, from the expressions (1), (2) we also get

$$\rho(\theta) = \frac{D_0}{1 + f(\varphi)} \quad (0 \leqslant \varphi \leqslant \varphi_1),$$ (5)

from which using f(φ) and its derivatives we can also represent the requirement of convexity of the curve ρ(θ) as

$$C(\rho) = \frac{D_0^2}{f^3(\varphi)[1 + f(\varphi)]^3} [f(\varphi)f''(\varphi) + f^3(\varphi) + f'(\varphi) - f'^2(\varphi)] > 0$$

$$(0 \leqslant \varphi \leqslant \varphi_1).$$ (6)

Below we provide two methods to solve the current problem of design starting from the function f(φ). In these methods it is supposed that arc measure $\varphi_1 < \frac{\pi}{2}$, and that this restriction basically conforms to the actual conditions. But if in an extremely special problem opposite conditions were to occur then segmentation could be used in the design making the arcs of each segment $\frac{\pi}{2}$.

§2. Integration Solution Method

In order to design a pair of rolling, convex curve segments r = r(φ), ρ = ρ(θ) satisfying requirements i) - iv) of the previous section we must first begin with the major contradiction of convexity. Here from the train of thought in reference [2] we can design second order smooth curves where the initial and final first and second order rates of change are zero.

First we note in reference [2] second order rates of change are all curves designed to be antisymmetric with respect to a central point in the region. So it is not difficult to see that in the design of the f''(φ) the first restriction called for is

$$\max_{[0,\varphi_1]} |f''(\varphi)| < \min_{[0,\varphi_1]} [\min(f(\varphi), f^2(\varphi))],$$ (Δ_1)

Then it can be guaranteed that the corresponding rolling curves r = r(φ), ρ(θ) from above are both convex. Actually, noting the above situation and the property of f(θ) > 0 from the section above here we get the relation:

$$2f'^2(\varphi) + f^3(\varphi) + f^2(\varphi) - f(\varphi)f''(\varphi) > f^2(\varphi) - f(\varphi)f''(\varphi)$$

$$= f(\varphi)[f(\varphi) - f''(\varphi)] \geqslant f(\varphi) [\min_{[0,\varphi_1]} f(\varphi) - \max_{[0,\varphi_1]} f''(\varphi)] > 0,$$

$$0 \leqslant \varphi \leqslant \varphi_1,$$

from which we see that with relation (4) established then the corresponding r(φ) in convex.

34

Similarly, from the special characteristic noted above for the "integration solution method," we also have (note that $\varphi_1 < \dfrac{\pi}{2}$ is already established)

$$\max_{[0,\varphi_1]}|f'(\varphi)| = \left|f'\left(\frac{\varphi_1}{2}\right)\right| = \left|\int_0^{\frac{\varphi_1}{2}} f''(\varphi)d\varphi\right|$$

$$\leqslant \frac{\varphi_1}{2}\max_{[0,\varphi_1]}|f''(\varphi)| < \max_{[0,\varphi_1]}|f''(\varphi)|,$$

and thus similarly from the assumption of (Δ_1) it can be derived that

$$f(\varphi)f''(\varphi) + f^2(\varphi) + f'(\varphi) - f'^2(\varphi)$$
$$= f(\varphi)[f(\varphi) + f''(\varphi)] + (f'(\varphi))^2 - (f'(\varphi))^2$$
$$\geqslant f(\varphi)\left(\min_{[0,\varphi_1]}f(\varphi) - \max_{[0,\varphi_1]}|f''(\varphi)|\right) + \left(\min_{[0,\varphi_1]}f^2(\varphi)\right)^2 - \left(\max_{[0,\varphi_1]}|f'(\varphi)|\right)^2$$
$$> 0 + \left(\min_{[0,\varphi_1]}f^2(\varphi)\right)^2 - \left(\max_{[0,\varphi_1]}|f''(\varphi)|\right)^2 > 0,$$

So we also know with relation (6) established $\rho(\theta)$ must also be convex. In this way, the restrictive condition of the original problem iv) and the meshing of ii) are both satisfied. Lastly, noting relationship (2') the other restriction of the original problem can be transformed to a relationship of $f(\varphi)$

$$f(0) = \frac{r(0)}{D_0 - r(0)} = \frac{r_0}{\rho_0}, \; f(\varphi_1) = \frac{r(\varphi_1)}{D_0 - r(\varphi_1)} = \frac{r_1}{\rho_1},$$

$$\int_0^{\varphi_1} f(\varphi)d\varphi = \theta_1. \tag{**}$$

Consequently it is not hard to determine that with the "trapezoidal method" of reference [2] for the integration relation above one gets $h = \max_{[0,\varphi_1]}|f''(\varphi)|$

(If one uses "pair order square (high order) parabolic method" to design $f''(\varphi)$ then it is more trouble because n is an integer. In these cases first get an estimate of n by transformation then fix $a = \max_{[0,\varphi_1]}|f''(\varphi)|$).

In order to broaden the applicability of the above method of course we want to be able to have bigger permissible values of $\max_{[0,\varphi_1]}|f''(\varphi)|$ and consequently to correspondingly be able to have larger "magnification" of $f(0)$ to $f(\varphi_1)$. Because of this we can provide the restriction

$$\max_{[0,\varphi_1]}|f''(\varphi)| < \min\left\{\min_{[0,\varphi_1]}\left[f(\varphi) + f^2(\varphi), \frac{2}{\varphi_1}f^2(\varphi)\right], \left(\frac{f(0) + f(\varphi_1)}{2}\right)^2\right]\right\}. \tag{Δ_2}$$

Actually, in view of the easily verified relation (4) this is already satisfied. Similarly, from the special design characteristics of the "integration solution method" it is known: if $f(\varphi)$ (monotonicly decreases), then $f''(\varphi)$ is only negative in $\left[\dfrac{\varphi_1}{2}, \varphi_1\right]$ (or correspondingly $\left[0, \dfrac{\varphi_1}{2}\right]$) so we have

when $\varphi \in \left[0, \frac{\varphi_1}{2}\right]$ 时 $\left(\left[\frac{\varphi_1}{2}, \varphi_1\right]\right)$, $f(\varphi)f''(\varphi) + f^3(\varphi) > 0.$

when $\varphi \in \left[\frac{\varphi_1}{2}, \varphi_1\right]$ 时 $\left(\left[0, \frac{\varphi_1}{2}\right]\right)$, $f(\varphi)f''(\varphi) + f^3(\varphi)$

$$= f(\varphi)[f^2(\varphi) + f''(\varphi)] \geqslant f(\varphi) \left[\min_{[\frac{\varphi_1}{2},\varphi_1]} f^2(\varphi) - \max_{[0,\varphi_1]} |f''(\varphi)|\right]$$

$$\left(\geqslant f(\varphi)\left[\min_{[0,\frac{\varphi_1}{2}]} f^2(\varphi) - \max_{[0,\varphi_1]} |f''(\varphi)|\right]\right.$$

$$= f(\varphi)\left[f^2\left(\frac{\varphi_1}{2}\right) - \max_{[0,\varphi_1]} |f''(\varphi)|\right]$$

$$= f(\varphi)\left[\left(\frac{f(0) + f(\varphi_1)}{2}\right)^2 - \max_{[0,\varphi_1]} |f''(\varphi)|\right] > 0$$

and the relationship

$$f^4(\varphi) - f''^2(\varphi) \geqslant \left[\min_{[0,\varphi_1]} f^2(\varphi)\right]^2 - \left[\frac{\varphi_1}{2} \max_{[0,\varphi_1]} |f''(\varphi)|\right]^2 > 0, \quad \varphi \in [0,\varphi_1],$$

consequently

$$f(\varphi)f''(\varphi) + f^3(\varphi) + f^4(\varphi) - f''^2(\varphi) > 0 \quad (0 \leqslant \varphi \leqslant \varphi_1).$$

which is precisely a derivation of relationship (6).

§3.　Solution by Positive Coefficients of Exponential Functions

We again begin from the major contradiction of the "convexity" of the two curves noting the relationships (4) and (6) of section §1 with respect to the "gear ration" function

$$f(\varphi) = \alpha e^{\beta\varphi} \quad (\alpha > 0)$$

can be satisfied simultaneously so below we discuss an even more general function

$$F_n(\varphi) = \sum_{k=1}^{n} \alpha_k e^{\beta_k\varphi} \quad (\alpha_k > 0, \beta_k \text{sync}, k = 1, 2, \cdots, n). \tag{Δ_3}$$

Because this time from relation (Δ_3) we get

$$F_n F_n'' - F_n'^2 = (F_{n-1} + \alpha_n e^{\beta_n\varphi})(F_{n-1}'' + \alpha_n \beta_n^2 e^{\beta_n\varphi}) - (F_{n-1}' + \alpha_n\beta_n e^{\beta_n\varphi})^2$$

$$= (F_{n-1}F_{n-1}'' - F_{n-1}'^2) + \alpha_n\beta_n^2 e^{\beta_n\varphi}F_{n-1} + \alpha_n e^{\beta_n\varphi}F_{n-1}'' - 2\alpha_n\beta_n e^{\beta_n\varphi}F_{n-1}'$$

$$= (F_{n-1}F_{n-1}'' - F_{n-1}'^2) + \sum_{k=1}^{n-1} (\beta_k - \beta_n)^2\alpha_k\alpha_n e^{(\beta_k+\beta_n)\varphi}, \tag{7}$$

with the result that by induction it is not hard to verify that the function $F_n(\varphi)$ of the form (Δ_3) is always able to satisfy relationship (6), that is the curve segment $\rho = \rho(\theta(\varphi))$, $0 \leqslant \varphi \leqslant \varphi_1$ is always convex.

36

This way, in the collection of positive coefficients of exponential functions of the form (Δ_3), each (positive) function

$$f_k(\varphi) = \alpha_k e^{\beta_k \varphi} \quad (\alpha_k > 0)$$

satisfies the convexity characteristic relationship (*) in section §0:

$$2f_k'^2(\varphi) + f_k^2(\varphi) - f_k(\varphi)f_k''(\varphi) > 0 \quad \left(0 \leqslant \varphi \leqslant \varphi_1 < \frac{\pi}{2}\right), k = 1, 2, \cdots, n$$

With the result that when its exponents β_k are simultaneously positive (or negative) since they can be expressed in the form $x_k(y)$ $(y_k(x))$ and we have,

$$x_k''(y) < 0 \ (y_k''(x) < 0), \ k = 1, 2, \cdots, n,$$

then the corresponding function

$$X_n(y) = \sum_{k=1}^{n} x_k(y) \left(Y_n(x) = \sum_{k=1}^{n} y_k(x) \right)$$

can be derived and we must have the relationship

$$X_n''(y) < 0 \ (Y_n''(x) < 0).$$

Thus the polar coordinate equation

$$F_n(\varphi) = \sum_{k=1}^{n} f_k(\varphi)$$

corresponding to the function must also satisfy the relationship

$$2F_n'^2(\varphi) + F_n^2(\varphi) - F_n(\varphi)F_n''(\varphi) > 0 \quad \left(0 \leqslant \varphi \leqslant \varphi_1 < \frac{\pi}{2}\right).$$

Hence we can derive a function $F_n(\varphi)$ of the form (Δ_3) also always able to satisfy the requirement (4), that is the corresponding curve segment $r = r(\varphi)$, $0 \leq \varphi \leq \varphi_1$ is always convex.

After resolving this major problem of the two meshed segments being convex the remaining tasks can be fixed with α_k, β_k $(k = 1, 2, \ldots, n)$ by the other restrictions. For example, the three other restrictions outlined above can be transferred into three equations

$$F_n(0) = \sum_{k=1}^{n} \alpha_k = \frac{r_0}{\rho_0}, \ F_n(\varphi_1) = \sum_{k=1}^{n} \alpha_k e^{\beta_k \varphi_1} = \frac{r_1}{\rho_1},$$

$$\int_0^{\varphi_1} F_n(\varphi)d\varphi = \sum_{k=1}^{n} \frac{\alpha_k}{\beta_k} (e^{\beta_k \varphi_1} - 1) = \theta_1. \quad (\text{***})$$

When solving the problems we can select the values of n appropriately according to the number of restrictions and the calculation convenience.

Supplementary note 1) from section §0 it is easily seen that if we already have two sets $r_1(\varphi)$, $\rho_1(\theta)$ and $r_2(\varphi)$, $\rho_2(\theta)$ which satisfy the conditions i) – iv) in section §1, then when $r_1'(\varphi)$, $r_2'(\theta)$ are the same sign in the interval $[0, \varphi]$ then the curve segment

$$r(\varphi) = \frac{1}{2}\,[r_1(\varphi) + r_2(\varphi)], \quad \rho(\theta) = \frac{1}{2}\,[\rho_1(\theta) + \rho_2(\theta)]$$

must also be a solution of the original problem. From this we can adjust the value of the first and second order rate of change at the initial and final point.

2) The function of the form (Δ_3) in section §3 can also be expanded to the situation when the exponents $\bar\beta_k$ $(k = 1, 2, \ldots, n)$ are not of like sign. At those times from (7) we know (6) is still established, that is $\rho = \bar\rho\,[\theta(\varphi)]$ $(0 \le \varphi \le \varphi_1)$ is still convex; and from the relationship of the corresponding meshing curve segment $r = \bar r(\varphi)$

$$2\bar F_n'^2 + \bar F_n^2 - \bar F_n \bar F_n'' = 2(\bar F_{n-1}' + \alpha_n \bar\beta_n e^{\beta_n \varphi})^2 + (\bar F_{n-1} + \alpha_n e^{\beta_n \varphi})^2$$
$$- (\bar F_{n-1} + \alpha_n e^{\beta_n \varphi})(\bar F_{n-1}'' + \alpha_n \bar\beta_n^2 e^{\beta_n \varphi}) > 2(\bar F_{n-1}'' + \bar F_{n-1}^2 - \bar F_{n-1} \bar F_{n-1}'')$$
$$+ \sum_{k=1}^{n-1} (2 + 4\bar\beta_k \bar\beta_n - \bar\beta_k^2 - \bar\beta_n^2)\alpha_k \alpha_n e^{(\beta_k + \beta_n)\varphi},$$

we know easily that if

$$2 + 4\bar\beta_i \bar\beta_j - \bar\beta_i^2 - \bar\beta_j^2 \ge 0, \quad \forall i, j = 1, 2, \cdots, n,$$

then by induction the previous equation must be greater than 0, thus $r = \bar r(\varphi)$ $(0 \le \varphi \le \varphi_1)$ is also convex. Of course the above constraining conditions cause greater restrictions on the applications.

REFERENCES[*]

1. Ding Guanggui, "Cam Curves and Push Rod Shengcheng Curves," SHUXUE DI SHIXIAN YU RENSHI [MATHEMATICS IN PRACTICE AND THEORY], No 3, 1976, pp 40-44.

2. Ding Guanggui, "A Method Designing High-Speed Cam Transition Curves---"Integrative Solution," Ibid., No 1, 1977, pp 49-53.

*The original versions of these two references were written collectively with students.

APPLIED SCIENCES

MICROCOMPUTER BASED AIRCRAFT COMMAND GUIDANCE SYSTEM DESCRIBED

[Article by Liu Xiaoyong [0491 2400 0516], Ministry of Aeronautics Industry, Research Institute No 613: "Applications for Microcomputers in Intercept Air Command Guidance Systems"]

[Text] In future air attack and anti-air attack combat that is multi-directional, multi-faceted, and multi-sortied, the interceptor will be able to take the object of its aerial attack by surprise, due to its small size, fast speed, and maneuverability. Therefore, it holds a decisive position in territorial air defense.

Because of limitations in the performance of current airborne equipment, it is very difficult to successfully hit an aerial target by only relying on the interceptor's autonomous guidance equipment to carry out long distance guidance. It must be closely coordinated with ground control guidance equipment before it can be fully effective. Command guidance in the past has relied on implementation by manual calculations, and a qualified navigator must memorize from 1,000 to 2,000 commonly used data, as well as provisionally plot and calculate. When encountering a greater number of targets or complicated situations, there are too many things to take care of, and the combat opportunity is threatened. Therefore, we are using the microcomputer for real time management of command guidance equipment, and coordinated control.

I. Overall System Structure

Since the 1950's, interceptor air military command guidance has been a task manually calculated and plotted. For command it was necessary to have a large command group staffed with a command leading officer, a navigation staff officer, operations staff officer, as well as plotting personnel. As for equipment, there was only guidance radar displays, aerial transmitters, and plotting boards. After microcomputers were incorporated into interceptor air military command guidance systems, this caused a great revolution in command, which removed itself of obsolete manual tasks and entered the electronics age, the number of people was reduced, and equipment was completely updated.

These command guidance systems are composed of radar, graphics transmitters and receivers, data recording equipment, quadratic displays, command guidance controllers, aerial radio communications equipment, real time components, and microcomputers. Overall system structure is as shown in Figure 1.
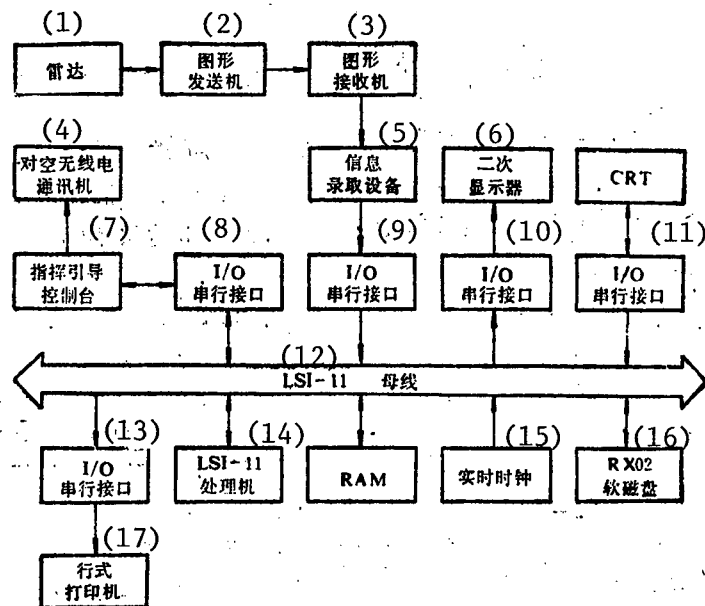
Figure 1. Schematic of Overall System Structure

Key:
1. Radar
2. Graphics transmitter
3. Graphics transmitter
4. Aerial radio communications equipment
5. Information recording equipment
6. Quadratic display
7. Command guidance controller
8. I/O serial interface
9. I/O serial interface
10. I/O serial interface
11. I/O serial interface
12. LSI-11 bus
13. I/O serial interface
14. LSI-11 processor
15. Real time clock
16. RX02 floppy disks
17. Line printer

We will now briefly discuss the relevant components and equipment functions.

Data Recording Equipment. Converts the analog quantity of the service flow data transferred from the graphics receiver to digital quantities, and also converts polar coordinates into rectangular coordinates and sends them to the computer. This is like a computer's A/D component.

Quadratic Display. Dynamically displays the aerial service flow motion path, and also displays the required ground coordinates and strategic areas, for full reference by the command. This is comparable to a computer's output equipment.

Command Guidance Controller. Aerial command and dispatching, guidance parameters binding, and manual intervention in the system during operations are necessary tools for human-machine interaction.

Microcomputers. The microcomputer is the heart of the entire guidance system, and is responsible for the collection and processing of aerial service flow data and real time calculations, as well as for sending the results to the quadratic display and command guidance controller, to serve as reference for commanders and navigators, and to determine battle plans; in another aspect, it also sends a portion of the results to the printer for print out, as well as recording on disk, all for criticism and learning from experience, and can also serve as long term preservation in archives of battles examples.

II. Selection of a Computer

From the point of view of tasking characteristics this system is a computer closed loop control system that is responsible for the tasks of data collection and handling. This requires that the computer CPU be set up with a rather complete interrupt processing capability, and also requires components with a highly accurate real time clock that can handle urgent situations in a timely manner. As for data sampling and real time control, this requires that the computer have a powerful logic decision capability and complete peripheral control instructions, while the requirements for operational capability are slightly lower by comparison. Overall system requirements are for at least the ability to complete 4:4 command guidance calculations (i.e., dispatch four interceptors to serve four targets), but for leeway, we design for the capability of doing 5:5. Currently, the command guidance radar that is used sweeps through one cycle in 10 seconds. That means that within 10 seconds the computer must not only do data information collection on 10 objects, but also be able to calculate in real time, as well as output the results of the calculations within the same 10 seconds, to control the aerial service flow.

The system overall requires that distance errors be less than 1 km and positional error be less than 0.3 degrees. Assume that this command defense area has a radius of 350 km. If the digit conversion portion requires 11 bits of binary data, a symbol takes 1 bit, and effective digits 10 bits, that is to say that the resolution ratio is about 0.098 percent and the distance conversion error is 0.342 km, which satisfies the requirements. Therefore, in considering word length, it would be best to select a computer with a word length greater than 12 bits.

This system is ground equipment, but it must be able to be placed on construction vehicles and moved any time, so it is necessary for the size to be as small as possible and for power consumption to be low, which means that

micro and mini computers would be best. But we considered that the performance to price ratio must be high, available system software must be appropriate, and that it must be able to do real time processing, and applications software must be conveniently written and revised.

Another selection criterion that could not be overlooked: in the long range, it must be based upon a device that is domestically available or in current development, and that also will be produced in this country in the near future.

There are many computers that can satisfy the requirements above, from which we chose the PDP-11/23, which has an LSI-11 microprocessor, an RT-11 real time operating system, and in the future it will be relatively easy to finalize the design and batch produce using Chinese-made devices.

III. Principles for Setting Up Mathematical Modeling of Aircraft Motion Paths and Guidance Calculation Methods

Due to the facts that in the process of moving within air the performance of an aircraft will vary according to complicated atmospheric influences, that data collection time can be delayed or erroneous, and that there can be loss of opportunity in pilot manual operations all make it very difficult to be accurate in mathematical modeling of aircraft motion paths. We have used the so-called minimum squares method principles to work out the aircraft motion path. Given the group N analog collected by radar, it becomes the group N digital data after conversion by data recording equipment:

x_1	x_2	x_3	...	...	x_N
y_1	y_2	y_3	...	...	y_N

then we can obtain the polynomial y(x), where the frequency is lower than N-1:

$$y(x) = a_0 + a_1 x + a_2 x^2 + \cdots\cdots + a_m x^m \quad (m < N - 1) \tag{1}$$

In level flight for the aircraft we take m = 1, where its motion path approaches a straight line, i.e.,

$$y(x) = a_1 + ax \tag{2}$$

During variable flight, the motion path can be described using a polynomial where m = 5, i.e.,

$$y(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5 \tag{3}$$

From polynomials (2) and (3) we can obtain the motion parameters for current aircraft position, direction, and speed. We can go on to guess at the aircraft's future path based on the vector addition method, to predict and control it (Figure 2).

42
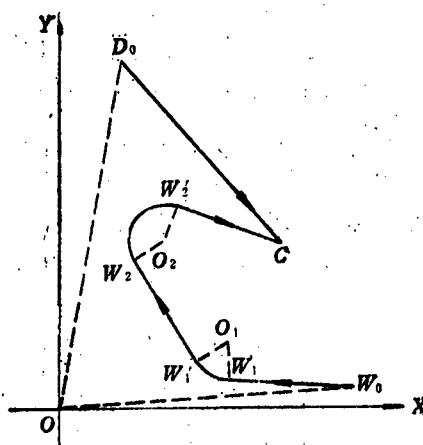
Figure 2. Diagram of a Service Flow Aerial Motion Path

Given that when guidance has begun the objective of intercept is at position D_0 and the interceptor is at W_0. Based on forecasting, the interceptor ought to make its first dynamic turn at point W_1 and then level off at point W_1'; it should make its second dynamic turn at point W_2 and level off at point W_2'; then it should fly in a straight line meeting the target at point C. If point C exists, then by the principles of vector summation $OW_0W_1O_1W_1'W_2O_2W_2'CD_0O$ ought to form a closed figure and we can express it with the vector equation

$$\overrightarrow{OW_0} + \overrightarrow{W_0W_1} + \overrightarrow{W_1O_1} + \overrightarrow{O_1W_1'} + \overrightarrow{W_1'W_2} + \overrightarrow{W_2O_2} + \overrightarrow{O_2W_2'} + \overrightarrow{W_2'C} = \overrightarrow{OD_0} + \overrightarrow{D_0C} \qquad (4)$$

Because we have obtained the aircraft motion parameters, we may solve for this vector equation. Therefore, more accurate predictions and real time control of aircraft motion paths are possible.

For guidance methods we use autonomous guidance methods and ground guidance methods. The possibilities for autonomous guidance methods are chiefly derived from the capabilities of aircraft and their electrical equipment and armament systems and the flight characteristics of the target, so they are not within the scope of this paper. Among ground guidance methods are mainly used the guidance methods of linear approximation, seeking, dynamic method, and quadratic turns.

The linear guidance method is also called the prediction method, as it primarily guides the interceptor on a direct flight to the point of intersection with the target. If the relative positions and flight paths of the interceptor and target are suitable to the interceptor combat characteristics, this method may be used. This method uses few operational parameters, control is simple, and it is easy to discover the target.

When the interceptor speed is far greater than the flight speed of the target, it is better to use the seeking method. This method produces few parameters, control is timely, it is easy to switch to autonomous guidance, and it allows the interceptor to find the target as quickly as possible.

43

The dynamic method is most often used. This method has accurate calculations, is easy for interceptor concealment, taking an advantageous position, making full use of firepower, flexible altitudes, and taking the target by surprise.

Due to the large expanse of our territory, national border defense is rather complicated, and sometimes flights outside our country will suddenly penetrate our airspace for reconnaissance or harassment, and then immediately run away. This then requires that interceptor command guidance be highly flexible and not waste time. At these times, using quadratic turns guidance will give the best results.

IV. Computer Interfacing and Machine Time Allocation

Within the entire command guidance system, the host processor LSI-11 has system control authority, and data and instructions are exchanged between the host computer and peripherals under its dispatch and control. Communications among all equipment in the system is all done through asynchronous serial interfaces, signal conventions corresponding to the RS-232C interface.

According to the data recording equipment software interface conventions, there are two types of output words, instruction and data.

Instruction words: output as special tasking functions.

Data words: output as data information of a certain variable, as in the coordinate values for x and y.

The baud rate selected is B = 9600 bits per second, which for serial transmission where a pulse indicates the two states of "0" and "1", the transmission cycle t is

$$t = \frac{1}{B} \approx 0.104 \text{ milliseconds}$$

For equipment that is serving under real time control, within each data collection cycle there needs to be a collection of service flow information, and after processing and calculations, an output of results in an orderly manner. Therefore, in the data collection cycle, times for information transmission and times for information processing and calculations must be accurately allocated.

Control of the sampling cycle T calculations is as follows:

$$T = n_1 \left(t_1 - \left(nt + n_2 \left(t_2 + t_3 \right) + n_4 t_4 \right) \right) \tag{5}$$

where t_1 = data collection cycle;
t_2 = interrupt response time;
t_3 = interrupt service time;
t_4 = disk access time;
n = number of binary digits to be transmitted;

44

n_1 = control sampling coefficient, = 1 in this system;
n_2 = interrupt control coefficient; and
n_4 = disk transfer control coefficient.

Because of restrictions due to the radar scanning cycle, t_1 in this system is 10 seconds.

For the PDP-11/23, t_2, t_2 averages 10 microseconds. In each data collection cycle, information recording equipment requests interrupts 55 times, the CRT requests interrupts 18 times, so n_2 = 55 + 18 = 73.

Interrupt service time depends on the length of the service routines and the processor instruction cycle. Because the information recording equipment uses split code, the longest interrupt service routines will be 40 instructions and the processor instruction cycle averages 1.5 microseconds, so t_3 = 60 microseconds.

Data transfer times include the serial transfer times for printers, information recording equipment, quadratic displays, passing through CRT bound guidance parameters, and data displays. Each cycle requires transfer of 330 digits or bytes, and in start-stop mode transfers each word use an 11-bit binary representation, so n = 330 X 11 = 3630.

Disk access operations are not requested in each cycle, in the worst case it is considered to be one access per cycle, thus n_4 = 1.

Therefore, $T = 10000 - (3630 \times 0.104 + 73 \times (10 + 60) / 1000 + 262) \approx 9355$ (ms)

We use the ratio of data collection to the control sampling cycle, μ, to represent the time allocated to the real time control system:

$$\mu = (10000 - 9355) / 9355 = 1/14.5$$

Practice has shown that the value of μ completely satisfies the requirements of the command guidance system.

V. Design of Command Guidance Control Software

For support of the RT-11 operating system there are the MACRO (macro assembler), FORTRAN, and BASIC languages. BASIC runs slowly and is not satisfactory for use; FORTRAN IV cannot be used for real time control; MACRO can be used for real time control but is not convenient for calculations involving large quantities of data. Therefore, for the interrupt control portions (the interrupt service routines) we use the MACRO language, while formula calculations are all written in FORTRAN. The two languages are linked through CALL statements.

1. Interrupt Service Routines

According to provisions of the RT-11 operating system, there are four levels of interrupts for standard peripherals.

After interrupt response to the split code sent from the information recording equipment, it is converted and processed into x,y coordinate information for the service flow current position, and is also provided with a mark to distinguish it. A particular data area is opened in the buffer to preserve the appropriate coordinate point values, which provides all necessary parameters for real time guidance calculation routines. Its level of interrupt ought to be somewhat higher, and is set at 5.

The real time clock is the overall coordinator for system operations, and its interrupt level is 6.

Figure 3 is a flowchart for the interrupt service routines.
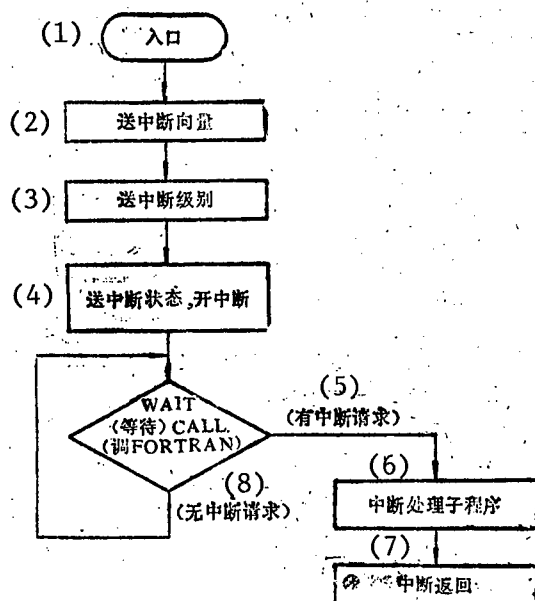
Figure 3. Flowchart of the Interrupt Service Routines

Key:
1. Entry
2. Send interrupt vector
3. Send interrupt level
4. Send interrupt status, enable interrupts
5. (There is an interrupt request)
6. Interrupt processing subroutines
7. Return from interrupt
8. (There is no interrupt request)

2. Real Time Guidance Calculation Routines

After a target has been sampled or time is up and the target has been lost, in either case the guidance calculation routines should be entered and data processing should be begun on service flow coordinate points. If the service flow coordinate position information is obtained from sampling, it should be smoothed and filtered; if service flow data is lost or drops through the sampling, the data that has been previously stored should be the basis for deduction from which to obtain an approximation of current position coordinates. The principle uses the minimal squares method discussed above.

After obtaining the approximate coordinates position for the airborne service flow, we can predict the future motion path of the target by vector summation, as well as measures that ought to be adopted by the interceptor: level flight time, dynamic times, turn directions, angles, altering flight path, estimated point of attack, and overall guidance time, etc. Figure 4 is a flowchart for the real time guidance calculation routines.
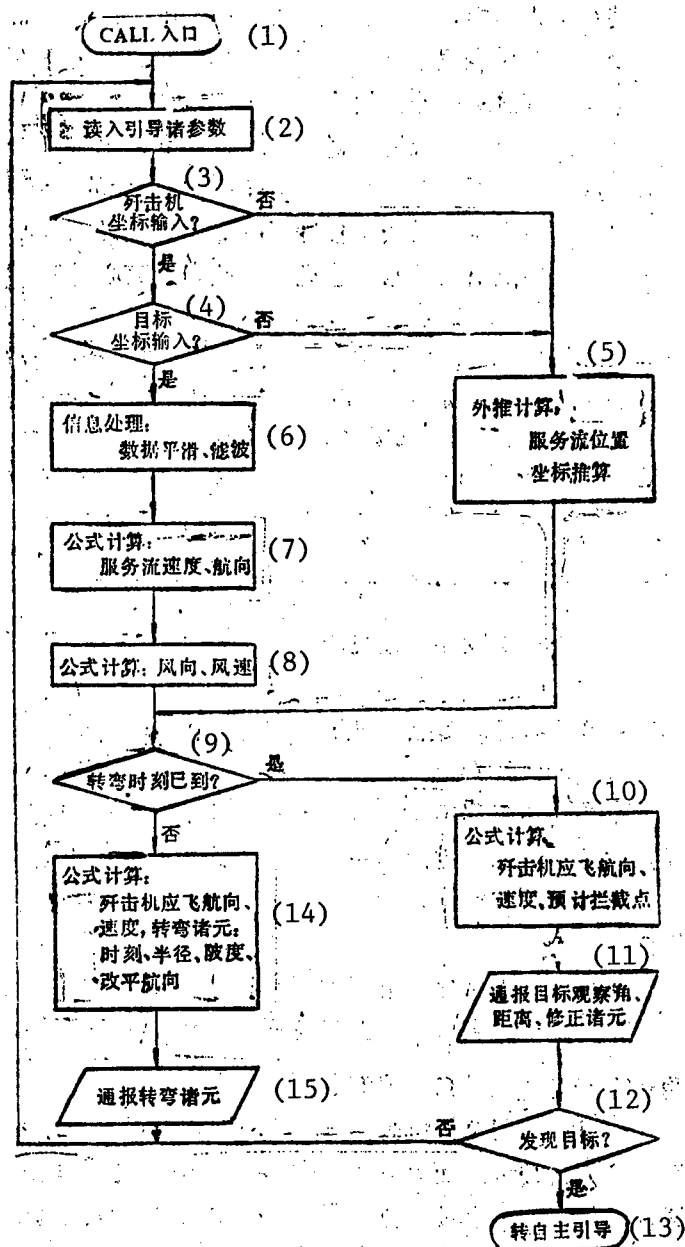
Figure 4. Flowchart of Real Time Guidance Calculation Routines

[Key on following page]

Key:
1. CALL entry
2. Read in guidance parameters
3. Intercept coordinates input?
4. Target coordinates input?
5. Deduction calculations: service flow position coordinate deductions
6. Information handling: data smoothing, filtering
7. Equation calculations: service flow speed, direction
8. Equation calculations: wind direction, wind speed
9. Time for turn?
10. Equation calculations: interceptor direction, speed, estimated point of interception
11. Report target angle of observation, distance, revision components
12. Target discovered?
13. Switch to autonomous guidance
14. Equation calculations: directory, speed, interceptor ought to fly; turn components: time, radius, angle, level-off direction
15. Report turn components

Also, this system has three dimensional calculations (waiting and preparation line, take-off line, and intercept line), outgoing routine calculations, intercept line optimization, fuel calculations, as well as return course guidance calculations.

VI. Conclusion

After microcomputers were incorporated into intercept air command guidance, the many faults of traditional manual guidance and plotting were overcome. Aerial service flow dynamics are automatically figured by the system, so information is automatically displayed on quadratic displays, the speed and accuracy of which are not obtainable manually, all of which has greatly improved the efficacy of intercept air forces. Command office civilian war service personnel are reduced by one-third and the plotting board is eliminated. There is only conversation between navigator and pilot, so the environment is quiet, which frees civilian war service personnel from anxious, taxing, and hectic manual tasks to concentrate their energies on understanding the plans of the commander, and to consider tactical and troop deployment. The entire set of equipment can be fitted onto a construction vehicle, it is flexible, and the price is not half of a foreign product of the same type. In the guidance process there is less manual interference, and instrument and gauge displays are visual and life-like. Operation is simple and easy to master, such that someone with a middle school education can be familiar with operations after 2 weeks of training, which aids in broadening its use.

This command guidance system has been checked out recently, receiving favorable reviews from officers and users. The system program was jointly designed by this office, the design department 081 of the Ministry of Electronics, and the PLA Unit 39834. Superintendent Zou Shenghuai [6760 4141 2037] 081 Design Department Head, Senior Engineer Lin Yuan [2651 3220], and Chief of Staff Lu Zuozhang [0712 0155 4545] took part in overall planning

48

and development. Senior Engineers Yang Zhi [2799 6347] and Li Haoshui [2621 3185 3055] carefully looked over the manuscript of this paper, as well as offering many ideas for revision, for all of which I express my appreciation.

REFERENCES

1. Digital Equipment Corporation, "Microcomputers and Memories," 1981.

2. E.C. (WEN-TE-QIE-LE), "A Guide to Modern Operations Research," 1964. Zhou Fang, Yu Yu trans., National Defense Publishing, 1976.

12586/6091
CSO: 4008/1083

APPLIED SCIENCES

FIFTH GENERATION COMPUTER DISCUSSED

[Article by Wu Lide [0702 4539 1795] of Fudan University: "Talking About the 5th Generation Computer"]

[Excerpts] I. A brief evaluation of the planned formation process of the Japanese fifth generation computer system, its content, conditions for progress, and some relevant discussion and debate are presented.

II. The so-called fifth generation computer system will be a computer series that uses a common program design language. Overall, it will mutually connect up into a network; in parts, each node on the information processing network discussed above [deleted] will itself be a computer system using a network of parts that will be linked up. They will provide three basic functions: intelligent interfacing, management of a store of knowledge, and problem solving and reasoning.

III. The fifth generation computer system constructed to be able to fulfill various different application requirements, is implemented through the following levels: basic software system, program design language, the computer system architecture, and VLSI technology.

IV. From the point of view of current conditions work has progressed rather smoothly. Good progress has been made in the aspects of the inference machine, data base machine, and kernel language. For example, an important goal for the first stage was to develop an individual sequential inference machine. This can directly support the page 0 kernel language KLD, which is a kind of logical program design language like the current PROLOG. Its speed is 20k to 30k LIPS, with a main storage capacity of from 2 to 16M words (a word being 40 bits). At present, a test installation has been set up at Tokyo University, the hardware portion of which is borrowed from the existing data flow machine, TOPSTAR-I. This data flow machine is composed of 24 microcomputers, of which 8 are used as communications control modules, and the other 16 microcomputers are used as processing modules. Each microcomputer has a Z80 CPU with 16k RAM and an I/O interface board. The language used is a Japanese self-designed parallel PROLOG language called PARALOG. The results of initial testing have been satisfying, and have greatly increased the speed of logical inferencing.

V. In sum, the fifth generaton computer system is, after all, an enormous project still ongoing, many things still await constant clarification in research, and there is the possibility that it will fail. But, to have been able to systematically begin to propose and undertake research in this area before 1979, and then to step by step commit it to implementation, is a very valuable kind of exploratory spirit and practical attitude.

VI. From the point of view of China's current situation, if we are to immediately begin research on fifth generation computing systems on a large scale, there are definite problems. Nevertheless, research into fifth generation computers is a requirement for social development, and is a necessary step for the advance of science and technology. The primary goals and significance for studying fifth generation computers are: 1) to suit the requirements of the information transformation of the nineties, to stimulate the development of the entire industrial system, and to encourage a far ranging improvement in social production forces and economic results; 2) to develop computer systems with a high degree of intelligence, as well as to open new application areas; 3) to eliminate current limits on technology, to develop new theories, new technology, new crafts, and new materials, to research new types of VLSI, and to research new computer systems oriented toward intelligent processing.

We ought to notice: that although Japan has great quantities of equipment for electronic technology they have not yet reached a stage that may be called a technological revolution. Although they are promoting and setting up plans for the fifth generation computer, their software still depends on imports. Looking then at China, we currently already have an electronics industry of a basic equipment level, a complete system of computer research, production, application, and service is already beginning to form, and even more importantly, our computer science and research ranks have rather high scholastic attainment. Therefore, we ought not to blindly despise, but should take more seriously this aspect of study and adopt corresponding policies. As a first step, it seems we should arrange a few points in a systematic fashion, we should collect relevant materials and participate in relevant international conferences to get close to trends in this field, and we should support some units developing their theoretical work. In fact, as stated above, the experimental TOPSTAR-I uses mainly 24 microcomputers, and these kinds of conditions can be completely met domestically. In this way, once technological conditions have been met we can develop work in this area more quickly, and rapidly lessen the disparity with international levels of advancement.

RECOGNITION DIRECTORS IN VECTORIZATION

[Article by Fan Zhihua [5400 2784 5478], Wu Jianan [0702 0256 1344], Guo Qiang [6753 1730], and Wei Kuichao [7614 1145 6389] of Changsha Institute of Technology; manuscript received in February 1984 and revised in March 1984]

[Text] Abstract: Based on the vectorizers of the vector computer, the definitions of recognition directors are introduced. A better design method is presented.

I. Significance of Recognition Directors

The Galaxy supercomputer (on the order of 100 MIPS) and the Model 757 large computer (10 MIPS) are vector computers developed in China. Their hardware can support vector operations and parallel processing.[1] The efficiency of vector computers, however, can only be fully utilized when this type of hardware structure is widely used. Therefore, vectorization of serial operations becomes one of the core technologies.

In the present vector recognition theory[2-6] and the practical, vector recognizers, source programs are not run in the recognition stage. Instead, the recognition and rewriting processes are carried out in the "static state." How does a "static process" utilize "dynamic information"? This is a topic of great concern in programming theory. Does a vector recognizer, which performs static processing of the source program, need some dynamic information? Please look at the following simple examples.

Example 1.   ......

INTEGER   K

......

$K = -1$

DO 1 $I = M, N$

$A(I+K) = A(I) * *2$

1 CONTINUE

......

Whether the DO 1 loop can be vectorized is determined by the constant K in the subscript expression I+K.[7] When K > 0, it cannot be vectorized, including the recursion in the statement. When K ≤ 0, it can be vectorized. Based on this we know that K affects the explicit data dependence in the loop.[8] Because it is a variable, the static processing vector recognizer still cannot vectorize this loop despite the fact that its entry value is -1.

Example 2.   ......

$$INTEGER \quad M, \ N$$

......

$$M = 1$$
$$N = 100$$
$$DO \quad 2 \quad I = M, \ N$$
$$A(I) = 1$$
$$A(2 * I) = 2$$
$$A(3 * I) = 3$$
$$2 \quad CONTINUE$$

Whether the DO 2 loop can be vectorized is determined by the lower limit M and upper limit N of the loop control variable. When M = 1 and N = 100, vectorization of the entire loop is possible. The statement sequence of the target program, however, is not consistent with that of the source program.[9] Because M and N depend on dynamically assigned values, the static processing vector recognizer has to give up rewriting the loop for vectorization.

Example 3.   ......

$$INTEGER \quad K$$

......

$$K = 1$$
$$DO \quad 3 \quad I = 1, \ N$$
$$A(I) = B(I) * C(I)$$
$$C(I) = B(I - K)$$
$$B(I) = A(I + K) * D$$
$$3 \quad CONTINUE$$

......

When K = 1, this loop can be vectorized. It is, however, necessary to add a series of temporary numbers in the target program.[9] Thus, the vector recognizer cannot vectorize this loop.

Example 4.
```
                        ......
            INTEGER   S
                        ......
            S=12
            DO  4  I=2,  100,  S**2/72
            A(I)=(A(I-1)+A(I+1))/2.0
        4  CONTINUE
                        ......
```

The step in the loop DO 4 is an expression containing variables. Normally,
the vectorization of a loop with an uncalculatable step is resolved by the
argumentation theory.[10] The process is to argument the steps to SIGN
(upper limit--lower limit) to be vector recognized. Just as applying the
absolute convergence theory to an interleaved series,

$$\sum_{n=1}^{+\infty}(-1)^{n-1}\frac{1}{n}$$

it cannot determine its convergence at all.

Example 5 (Example 5 in reference [8]).

```
            PROGRAM   TEC
            INTEGER   A(100),  B(100),  C(200),  D(100)
            EQUIVALENCE  (A,  C,  D)
            COMMON  A,  B
            DO  51  I=1,  100
        51  B(I)=C(I+99)
            DO  52  J=1,  99
        52  D(J)=B(J)
            END
```

Due to the effect of implicit data dependence, the loop DO 51 cannot be vec-
torized. When any implicit data dependence which might hinder vectorization
is identified, usually a warning message is sent as the analysis of the
strategy to vectorize continues. By doing so, despite the warning message,
the DO 51 loop is vectorized, resulting in errors in the calculation.

Example 6.
```
                        ......
            PARAMETER  (N=128)
            DIMENSION  A(N,  N),  B(N,  N),  C(N,  N)
                        ......
            DO  6  I=1,  N
            DO  6  J=1,  N
            C(I,  J)=0.0
            DO  6  K=1,  N
        6  C(I,  J)=C(I,  J)+A(I,  K)*B(K,  J)
```

The triple loop completes the following matrix multiplication:

$$C = A * B$$

The vector recognizer should use a highly efficient standard vector multiplication process to replace the serial loop in the source program, instead of rewriting the serial loop into vector operations.

Example 7.   ......

$$S = 0.0$$
$$\text{DO} \quad 7 \quad I = 1, \; N$$
$$7 \quad S = S + A(I)$$

                                ......

The single loop completes the summation process:

$$S = \sum_{i=1}^{N} A(i)$$

The vector recognizer should use a high efficiency vector summation function to replace the serial loop in the source program. Vectorization analysis should not be performed.

Based on these examples, a vector recognizer should provide the user with some supplementary information, primarily dynamic information missing in static recognition, in order to eliminate the uncertainty due to data dependence, to ensure the accuracy and reliability of the system, to utilize highly efficient programs and functions stored, and to realize certain special functions to be discussed later. Recognition directors are the means for the user to provide additional information, which is a type of man-machine communications.

II. Design of Recognition Directors

Recognition directors are means to provide additional information by the user to improve the recognition process. For a vector recognizer, it is supplemental information. Therefore, its presence will not affect other parts of the software, such as the running of the compiler. Thus, it can only appear as a comment line. Hence, it is natural to design the recognition director by condensing COMMENT DIRECTOR into the CDIR and adding a trailing symbol such as "$" to form a mnemonic symbol 'CDIR$' and put it in the label area and supplemental information in the statement area.

Based on Examples 1 and 4, the explicit data dependence in some loops is uncertain for a static recognizer. The user, however, is sure that the loop control variable can be forcefully replaced by three dimensional elements, without any analysis, to obtain vector operation statements by reviewing the flow chart of the program. Of course, the user may also realize that the loop may be vectorized by the recognizer without altering

the statement sequence or adding a series of temporary numbers.[11] For such loops, the user can inform the recognizer not to go through any analysis to improve the efficiency of the recognizer. This is an "argumented vectorization" recognition director. Since the vectorization is performed forcefully, no additional information is required. The statement area is left blank.

Examples 2 and 3 show that user entry of initial loop variable values can assist the recognizer to determine the explicit data dependence. Obviously, the premise is that these entry values are uniquely determined by the user ahead of time after reviewing the flow chart of the program. This is the "parameter value" type of recognition director. The statement area may be designed as a PARAMETER statement, however, the symbols in such PARAMETER statements are variables. Moreover, it is a comment line with respect to the compiler and does not perform its original function.

Example 5 shows that some implicit data dependence will lead to errors in vectorization. It is, however, not so all the time. If the user discovers that the vectorization of certain loops is incorrect at the prompt of the warning message,[8] he may ask the vector recognizer to pass them without any processing. This is a "special function" recognition director. Presently, there are:

CDIR$ PASSDOB   (pass the following loop)
CDIR$ TAKEDOI   (generate DO loop variable exit value statement)
CDIR$ PASSEG ON   (pass all statements to follow)
CDIR$ PASSEG OFF (do not pass all statements to follow)
CDIR$ ARRAYZE   (need to form array)

Example 6 shows that the user sometimes may want to replace a serial loop with a procedure call. This is a "procedure call" type of recognition director. Example 7 shows that the user sometimes may desire to inform the vector recognizer to replace a serial loop with a function reference. This is a "function reference" type of recognition director.

III. Argumented Vectorization Recognition Directors

Write format:

                    label area
           1   2   3   4   5   6   7 • • •   (line number)

           CDIR $

                                 DO $a\cdots$
                                 statement area
                                     for

           a argumented vectorization

56

Semantics:

1. Delete following statements (must be DO statements).

2. The following changes are made in the statement area until the end of the loop: using the upper limit, lower limit and step as three elements to mechanically replace any variables with the same names as the loop control variables to obtain three new symbols.

3. If a vector operation statement is found in the treatment, it will be argumentedly vectorized and then be input again. It is considered as a no-operation.

4. The accuracy of the target program is assured by the user.

5. The entry and termination labels are treated correspondingly.

The original vectorization as defined in reference [11] is, in principle, different from argumented vectorization. The original vectorization process involves a rigorous data dependence analysis (Theorem 1 in reference [11]). Its accuracy is guaranteed by the vector recognition theory. The vectorization process is automatically carried out by the vector recognizer. As for argumented vectorization, the system no longer relies on any data dependence analysis. Its accuracy is guaranteed by the user. The vectorization is carried out by the user (with the aid of recognition directors).

Example 8 (continuation of Example 1)

```
                        ......
              INTEGER  K
                        ......
              K = -1
      CDIR $
              DO  8  I=M,  N
              A(I+K)=A(I) * *2
8             CONTINUE
                        ......
```

The target program from the vector recognizer is:

```
                        ......
              INTEGER  K
                        ......
              K = -1
      CDIR $
              A(M+K:N+K)=A(M:N) * *2
```

57

Example 9 (continuation of Example 4)

```
                              ......
                    INTEGER  S
                              ......
                    S=12
        CDIR$
                    DO  9  I=2, 100,  S**2/72
                    A(I)=(A(I-1)+A(I+1))/2.0
        9           CONTINUE
                              ......
```

The vectorized target program is:

```
                              ......
                    INTEGER  S
                              ......
                    S=12
        CDIR$
                    A(2:100:S**2/72)=(A(1:99:S**2/72)+A(
              $       3:101:S**2/72))/2.0
```

IV. Recognition Directors for Setting Parameter Values

Write format:

$$\begin{array}{cccccccccc}
1 & 2 & 3 & 4 & 5 & 6 & 7 & \cdot & \cdot & \cdot
\end{array}$$

CDIR $ | Statement for setting vetorized parameters |

DO a ......

loop to be recognized
for
a vectorization

The statement for setting the value of a vectorized parameter is:

$$\text{PARAMETER} \quad (p=e[, \quad p=e]\cdots)$$

where p is a symbol and e is the expression of the constant, both are in full format.

The shape and semantics of a vectorized parameter value statement is similar to the PARAMETER statement in FORTRAN.[12] In this case, however, p is not (and should not be) a symbol for a constant.

58

Example 10 (continuation of Example 2)

```
                  ......
            INTEGER  M, N
                  ......
            M = 1
            N = 100
CDIR$  PARAMETER  (M=1, N=100)
            DO  10  I=M, N
            A(I)=1
            A(2*I)=2
            A(3*I)=3
10          CONTINUE
                  ......
```

Vectorized Target Program:

```
                  ......
            INTEGER  M, N
                  ......
            M=1
            N=100
CDIR$  PARAMETER  (M=1, N=100)
            A(3*M:3*N:3)=3
            A(2*M:2*N:2)=2
            A(M:N)=1
            I=N+1
                  ......
```

Example 11 (continuation of Example 3)

```
                  ......
            INTEGER  K
                  ......
            K=1
CDIR$  PARAMETER  (K=1)
            DO  11  I=1, N
            A(I)=B(I)*C(I)
            C(I)=B(I-K)
11          B(I)=A(I+K)*D
                  ......
```

The vectorized target program is[9]:

$$\cdots\cdots$$

$$\text{INTEGER} \quad K$$

$$\cdots\cdots$$

$$K=1$$

CDIR$ PARAMETER $(K=1)$

$$\#B(1:N)=B(1:N)$$

$$B(1:N)=A(2:N+1)*D$$

$$A(1:N)=\#B(1:N)*C(1:N)$$

$$C(1:N)=B(0:N-1)$$

$$I=N+1$$

$$\cdots\cdots$$

The statement to assign a value to a parameter does not have to be immediately in front of the parameter value recognition director. In reality, the vector recognizer does not care where a value is assigned to a parameter in the program.

V. Procedure Call Recognition Directors

Write format:

```
      1   2   3   4   5   6   7   .  .  .
```

CDIR $
> Standard procedure call
> statement in vectorization

DO $\alpha\cdots\cdots$

loop to be replaced to realize
the function of the
α procedure

or

CDIR $
> Standard procedure call
> statement in vectorization

> several assignment
> statements

DO α

loop to be replacec to realize

the function of the
α procedure

Several value assignment statements are sandwiched between the recognition director and the DO loop to assign initial values to some parameters.

Example 12 (continuation of Example 6)

```
                         ......
                 PARAMETER   (N=128)
                 DIMESION   A(N, N), B(N, N), C(N, N)
       CDIR$    CALL  MMULT(A, B, C, N)
                 DO  12  I=1, N
                 DO  12  J=1, N
                 C(I, J)=0.0
                 DO  12  K=1, N
       12        C(I, J)=C(I, J)+A(I, K)*B(K, J)
                         ......
```

The vectorized target program is:

```
                         ......
                 PARAMETER   (N=128)
                 DIMENSION   A(N, N), B(N, N), C(N, N)
                         ......
       CDIR$    CALL  MMULT  (A, B, C, N)
                 CALL  MMULT  (A, B, C, N)
                         ......
```

The first CALL statement is passed as a comment line by the compiler and only the second CALL statement is executed.

In addition to matrix multiplication, there are standard procedures for unity matrix, inverse matrix, linear equations and differential equations.

VI. Function Reference Recognition Director

Write format:

```
        1   2   3   4   5   6   7  .  .  .
       |___|___|___|___|___|___|___|___|___|_____

                                 _____
       CDIR$                    | Include assignment statement   |
                                | with vectorized function reference |
                                 --------------------------------
                                 DO  α ......
                                 _____
                                | loop to       |
         α                      |      be       |
                                | replaced      |
                                 ---------------
```

Or, several value assignment statements are inserted between the CDIR$ and DO statements. The function is the same as before.

Example 13 (continuation of Example 7)

$$...... $$

$$\text{CDIR \$}\quad S=\text{SUM}(A,\ N)$$
$$S=0.0$$
$$\text{DO}\quad 13\quad I=1,\ N$$
$$13\qquad S=S+A(I)$$

$$...... $$

The vectorized target function is:

$$...... $$

$$\text{CDIR \$}\quad S=\text{SUM}(A,\ N)$$
$$S=\text{SUM}(A,\ N)$$

$$...... $$

VII. Special Capabilities Specific to FORTRAN$_{66}$

The input program of the vector recognizer can be written in FORTRAN$_{66}$ or FORTRAN$_{77}$. After a loop is executed, whether the final value of the loop control variable remains will depend on the different requirements for FORTRAN$_{66}$ or FORTRAN$_{77}$ texts.[12] If the vectorization is carried according to the requirements of FORTRAN$_{77}$, it is necessary to generate an unnecessary statement for the exit value of the loop control variable that hinders the operating efficiency. Furthermore, even if the source program is a FORTRAN$_{77}$ program, not all exit values of the loop control variable are applicable. In view of this fact, we do not generate a statement for the exit value of the loop control variable when we vectorize a DO loop. The specific DO loop to generate such a statement is determined by the user by introducing the following recognition directors at that DO loop in the source program. By doing so, the efficiency of the vector recognizer can be improved.

Write format:

```
    1   2   3   4   5   6   7  .   .   .
    |   |   |   |   |   |   |   .   .   .

CDIR $              TAKEDOI
                    DO  a ......
                        loop
                        to be
    a                   vectorized
```

The character string TAKEDOI is a specific key word in the system which means that in the vectorization of the next DO loop it is necessary to generate a statement for the exit value of the loop control variable.

Example 14.

$$I = 2$$
$$\text{DO} \quad 14 \quad I = 1, \ N$$
$$14 \qquad A(I) = 1.0$$
$$\text{IF}(I.GT.10) \quad \text{GOTO} \quad 100$$
$$\vdots$$
$$100 \quad X = \cdots$$

Obviously, the exit value of the control variable in this example will be used in the next statement. Hence, we should introduce the recognition director described in this section, i.e.

$$I = 2$$
$$\text{CDIR\$} \quad \text{TAKEDOI}$$
$$\text{DO} \quad 14 \quad I = 1, \ N$$
$$14 \qquad A(I) = 1.0$$
$$\text{IF}(I.GT.10) \quad \text{GOTO} \quad 100$$
$$\vdots$$
$$100 \qquad X = \cdots$$

The vectorized target program is:

$$I = 2$$
$$\text{CDIR\$} \quad \text{TAKEDOI}$$
$$A(1:N) = 1.0$$
$$I = N + 1$$
$$\text{IF}(I.GT.10) \quad \text{GOTO} \quad 100$$
$$\vdots$$
$$100 \qquad X = \cdots$$

VIII. Specific Capabilities To Match Implicit Data Dependence

Example 5 shows that the presence of an implicit data dependence will bring uncertainty to the explicit data dependence analysis. Under the influence of implicit data dependence, in some cases vectorization is possible. In other cases, however, it is not possible, although the results of their explicit data dependence analyses are identical. Loops with data dependence hindering the vectorization process should be passed in the recognition stage and are not allowed in the analysis stage. The following recognition director performs this function.

Write format:

```
 1  2  3  4  5  6  7  . . .
```

CDIR$ PASSDOB

                         DO α ······

                         loop
                         to be
α   passed

The character string PASSDOB is a specific key word of the system which means that vectorization is not carried out for the next DO loop to leave the original serial form alone.

Example 15 (continuation of Example 5)

```
              PROGRAM  TEC
              INTEGER  A(100), B(100), C(200), D(100)
              EQUIVALENCE  (A, C, D)
              COMMON  A, B
     CDIR$    PASSDOB
              DO  301  I=1,  100
301           B(I)=C(I+99)
                     ······
              DO  302  J=1,  99
302           D(J)=B(J)
                     ······
              END
```

The vectorized target program is:

```
              PROGRAM  TEC
              INTEGER  A(100), B(100), C(200), D(100)
              EQUIVALENCE  (A, C, D)
              COMMON  A, B
     CDIR$    PASSDOB
              DO  301  I=1,  100
301           B(I)=C(I+99)
                     ······
              D(1:99)=B(1:99)
                     ······
              END
```

64

Similar to passing a DO loop, we can pass a section of the source program without performing vectorization.

REFERENCES

1. Ci Yungui [1964 7189 2710] and Hu Shuoren [5170 1343 0088], "A Survey of Supercomputer Architectures," DIANZI XUEBAO [ACTA ELECTRONICA SINICA], No 3, p 91, 1983.

2. D. Kuck, et al., "The Structure of an Advanced Vectorizer for Pipelined Processors," University of Illinois, 1980.

3. L. Lamport, "The Coordinate Method of the Parallel Execution of DO Loops," Proceedings of the 1973 Sagamore Computer Conference on Parallel Processing, 1973.

4. Wu Mingxia [0702 2494 7209] and Chen Huowang [7115 3499 2489], "Vectorization of Serial Operations," JISUANJI XUEBAO [CHINESE JOURNAL OF COMPUTERS], No 4, p 174, 1981.

5. Guo Qiang and Chen Haibo [7115 3189 3134], "Correlation Analysis in Vectorization of Serial Operations," to be published.

6. Fan Zhihua, "Subscript Tracking Method for Vectorization of Serial Operations," ZHONGGUO KEXUE [SCIENTIA SINICA], Series A, No 3, p 275, 1983.

7. L. Lamport, "The Parallel Execution of DO Loops," Com. Acm, 17(1974), No 2, p 83.

8. Fan Zhihua, Guo Qiang and Liu Huimin [0491 2585 3046], "Implicit Data Dependence in Vectorization," to be published.

9. Fan Zhihua, "Engineering Realization of Subscript Tracking in Vectorization," ZHONGGUO KEXUE [SCIENTIA SINICA], Series A, No 4, P 380, 1983.

10. Fan Zhihua, "Argumentation Theory and Its Application in Vectorization by Subscript Tracking," ZHONGGUO KEXUE [SCIENTIA SINICA], Series A, No 6, p 566, 1983.

11. Fan Zhihua, "Discrete Layers in Vectorization," to be published.

12. F.C. White, et al., "American National Standard Programming Language FORTRAN," American National Standards Ins., 1978.

APPLIED SCIENCES

NEW ZHI-8 HELICOPTER PASSES TRIALS WITH FLYING COLORS

[Article by Wei Jing [5633 5464] and A Zhou [7093 5297]]

[Text] The first test flight of the Zhi-8 helicopter was originally planned
for 9 December 1985. But on that day, a heavy snow storm unusual for the
southern part of the country forced the command center to postpone the flight.

On the 3rd day, i.e., 11 December, the snow stopped and the sky cleared up.
Outside Cicheng, the scenery appeared unusually bright with snow cover glitter-
ing in the sun. The change in the weather gave our spirits a sudden lift.

There was still a chill in the air; the airfield was surrounded by snow-covered
open space where cold wind continued to blow. However, on the airfield, the
air was filled with joy; flags fluttered in the wind, and a big crowd gathered.

A large red banner bearing the sign "Meeting of the Zhi-8 Test Flight" hung
high above the review stand. Sitting in the front row on the review stand
were: deputy chairman of the National Defense Science and Engineering Com-
mittee, Ye Zhengda, deputy minister of the Ministry of Aviation Industry, Wang
Ang, and deputy secretary of the Jiangxi Provincial Committee, Liu Fangren.
Officials from various military units, factories, bureaus and colleges as
well as experts and professors were also present at today's ceremony.

The flight test commander ran toward the review stand and reported that prepara-
tion work was completed. In response, deputy minister Wang Ang gave the order
to begin the test flight, and requested that the commander closely coordinate
with his people to ensure that nothing will go wrong. Shortly after, a green
signal light shot up into the sky, indicating that the flight test of Zhi-8
had officially begun.

The engine was started, and the huge rotor blade began to pick up speed, creat-
ing a strong cold draft, but the work crew busily trying to get the helicopter
ready did not seem to be bothered at all.

Suddenly this large grass-green machine lifted off the ground vertically and
hovered in mid-air. It remained completely still, as if it were suspended in
the air by an invisible wire.

Helicopters have the unique capability of "hovering." This capability is of great value in military operations as well in national economic development. In tank warfare, helicopters perform surveillance and fire missiles while hovering behind shielded objects; in anti-submarine warfare, helicopters can deploy sonars in the ocean while hovering; in supporting construction projects or transmission line projects, helicopters can be used to lift and install prefabricated parts while hovering in the air.

The Zhi-8 performed various types of flight maneuvers: forward, backward, left, right, and rotating 360 while hovering. Now it began to descend and landed vertically on the ground. But this was not the end of the program; gliding along the cleared runway, it took off again.

After flying for more than 30 minutes, the Zhi-8 returned to the airfield and landed precisely at a designated spot. It had completed a historical mission with flying colors. The crowd cheered, and balloons were released into the air among sounds of gongs, drums, and firecrackers.

Afterwards, the test pilot gave a report to the assembly saying that the Zhi-8 performed satsifactorily, all controls were normal and no malfunctions were encountered. A group of children rushed toward the pilot and presented him with flowers.

Deputy Chairman Ye Zhengda, Deputy Minister Wang Ang and Deputy Secretary Liu Fangren each gave a speech, in which they congratulated everyone for the successful test flight and encouraged the engineers and designers to coordinate closely with the technicians and work toward the common goal of developing China's helicopter industry.

The Zhi-8 is a large-medium size multi-purpose helicopter developed jointly by the Changhe Aircraft Factory of the Ministry of Aviation Industry and the Chinese Helicopter Design Institute. Premier Zhao Ziyang had visited the factory in person, which greatly boosted the morale of the personnel. In the process of developing this new aircraft, the Changhe Factory and the institute received support from dozens of different organizations around the country and solved many difficult technical problems. To facilitate the development process, a number of technical coordination meetings were sponsored by the Ministry of Aviation Industry to discuss various technical issues among different organizations.

The Zhi-8 has good performance and relatively long design life; it is safe and easy to operate. It can be used for transportation, air patrol, communications, as well as for rescue, surveillance and mapping missions; it has a wide range of potential military and civilian applications. The birth of Zhi-8 adds a new member to China's helicopter family and provides a new tool for the modernization of China's economic development and national defense.

3012/12232
CSO: 4008/54

EVOLUTION OF CHINA'S F-6, F-7 AIRCRAFT DETAILED

[Text]   The F-6 Attack Aircraft

The F-6 is a Chinese-built, single-seat twin-engine supersonic attack aircraft. It can be used for territorial air defense and for control of air space during combat; it can also be used on a specific ground support mission. The small, light F-6 aircraft is particularly well-suited for close-range combat missions because of its large thrust-to-weight ratio and high maneuverability. The aircraft has a simple structure and is easy to operate and maintain; it is also relatively inexpensive. The F-6 has a trapezoidal mid-wing with large backsweep and a large backswept tail section; the two engines are placed in parallel in the rear section of the fuselage and the air intake is located in the nose section. The cockpit has a zero-altitude rocket-propelled ejector seat which can be used in case of an emergency during take-off and for ejection parachuting exercises over water or at low altitudes. A compartment containing the braking chute is located below the rudder on the vertical tail; the braking chute can reduce the landing distance of the F-6 aircraft.

Power plant: Tow WP-6 turbojet engines with a maximum thrust of 2X2, 600 kg without afterburner and 2X3, 250 kg with afterburner.

Dimensional data: Wing span 9.0 m, length 12.54, height 3.89m, wing area 25.0 m^2.

Weight data: Empty weight 5,400 kg, normal take-off weight 7,500 kg (maximum 8,830 kg)

Performance data: Maximum level-flight speed M 1.35/1,450 km/hr (at an altitude of 10,000 m with no external attachments), service ceiling 17,500 m, maximum climb rate 180 m/sec (at an altitude of 5,000 m), range 2,100 km, take-off distance 515 m, landing distance 610 m.

The F-7 Light Attack Aircraft

The F-7 is a Chinese-built, single-seat light attack aircraft. It can be used for territorial air defense and for control of air space during combat; it can

also be used in ground attack missions. The aircraft has good flight performance, high maneuverability, and has intense firepower for close-range combat; it is small, light-weight, and is easy to oeprate and maintain.

The F-7 has a slender fuselage; the air intake located at the nose section is equipped with a zero-stage adjusting cone. The front section of the fuselage contains the cockpit and the equipment compartment, the rear section of the fuselage has large-backsweep vertical tail; there are also ventral fins underneath the fuselage and the entire horizontal stabilizer is movable. The wing uses a symmetrical airfoil section, its leading edge is a triangular surface with a 57° backsweep and a 2° dihedral. The trailing edge contains pneumatically-operated ailerons and floating type flaps. The cockpit cover is hinged and opens toward the rear. The cockpit is equipped with zero-altitude ejector seat whose ejection velocity is 180-850 km/hr. The seat height can be adjusted to give the pilot a good field of view. To provide a good working environment for the pilot, the temperature, pressure and oxygen supply inside the cockpit can be regulated automatically. The F-7 is equipped with tricycle landing gear and has a braking system as well as a braking chute to reduce its landing distance. The braking chute is located at the trailing edge of the vertical tail.

The F-7 attack aircraft is equipped with a WP-7B turbojet engine with afterburner. The maximum thrust is 4,400 kg without afterburner and 6,100 kg with afterburner. The engine performance has proven to be stable and reliable.

The aircraft has two 30-mm guns located on the both sides of the fuselage; the attachments below the wing can accommodate either 2 air-to-air missiles, 2 groups of 36 57-mm rockets, or 2 50-250 kg bombs; under overload conditions it can accommodate 2 500-kg bombs, and a 800-liter auxiliary fuel tank can be attached below the fuselage. The fire-control system of the F-7 is equipped with an SM-3A optical aiming device. An aerial gun camera is located in front of the aiming device.

To meet the requirements of both domestic and foreign customers, several improved models of the F-7 aircraft have been developed. One of the models has an advanced fire-control electronic system which includes the following items: 1) A head-up display unit which includes a weapon aiming computer; it has the capability of initiating a heat-ray attack, it can also be used for navigation display by interfacing with the inertial guidance system and the instrument landing system. 2) A frequency-hopping distance measuring radar which has good DM and interference rejection capabilities. 3) A modern atmospheric data computer. 4) A modern radar altimeter. 5) A multi-channel radio station with encryption device. 6) Two additional attachment units below the wing to accommodate a 480-liter auxiliary fuel tank, rockets, or air-to-air missiles.

Power plant: One WP-7B turbojet engine with a maximum thrust of 4,400 kg without afterburner and 6,100 kg with afterburner.

Dimensional data: Wing span 7.15 m, length 13.94 m, height 4.10 m, wing area 23 m^2.

Weight data: Empty wieght 5,150 kg, normal take-off weight 7,370 kg.

Performance data: Maximum speed M 2.05/2, 170 km/hr (at altitudes between 12,500 m and 18,500 m), static ceiling 19,200 m, service ceiling 18,800 m, maximum range 1,200 km (at an altitude of 11,000 m and carrying missiles), 1,490 km (carrying missiles and auxiliary fuel tank), take-off speed 310/320 km/hr, landing distance 800-1,000 m (with braking chute), maximum operating overload 7g (carrying 2 missiles).

3012/12232
CSO: 4008/54

PUBLICATIONS

TABLE OF CONTENTS OF HAIYANG XUEBAO VOL 7, NO 6, NOV 85

Beijing HAIYANG XUEBAO [ACTA OCEANOLOGICA SINICA] in Chinese Vol 7 No 6,
15 Nov 85

[Text] Table of Contents   Issue No   Page No

Marine Hydrology:

ACOUSTO-OPTICAL CORRELATOR IN RADAR SIGNAL PROCESSING

[Article by Xu Jieping [1776 0094 1627] and Yu Kuanxin [0205 1401 2450] of Department of Applied Physics, Beijing Industrial University]

[Abstract] The increase in the signal-to-noise ratio of the radar signal and the enhancement of its anti-interference capability are always among the major topics in radar signal processing. The paper studies the processing of radar signals with an acousto-optical (AO) correlator from the experimental viewpoint. Heights of correlation peaks at different pulse widths and different signal-to-noise ratios, and the magnitudes of correlation increment at different pulse widths are measured for centimeter wave band (3 GHz), single carrier frequency, rectangular pulse radar signal and interference by unmodulated random stray waves. When the pulse width is 2.5 μs, the correlation increment is 23 dB. At the output from the AO correlator, all correlation peaks are over tens of millivolts so that an oscilloscope can serve in direct monitoring without any amplification. The paper presents a space integration AO for experimental use; the following figure shows its optical path and electrical circuit system.
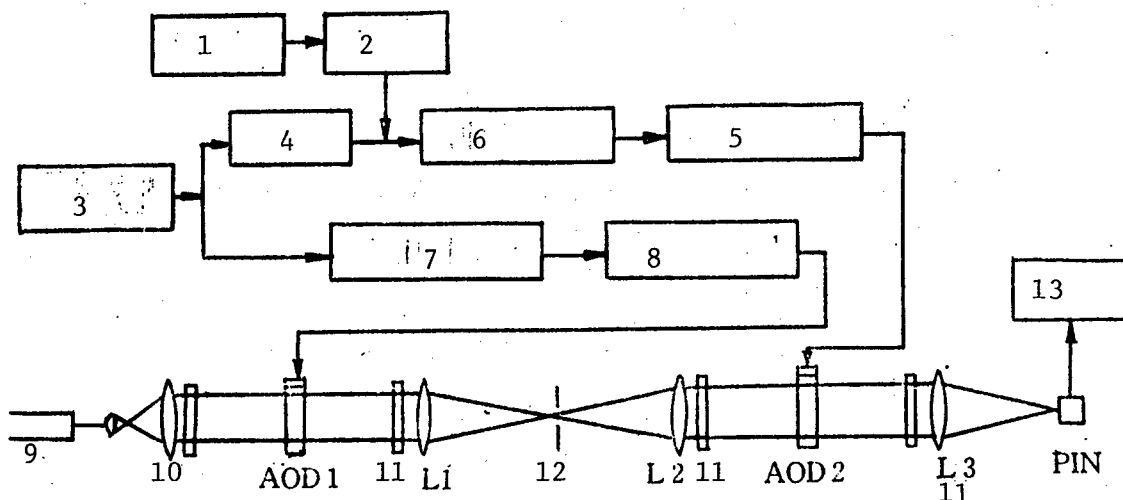
Key: 1. Interferometer; 2. Attenuator; 3. Radar signal producer; 4. Separator; 5. Power amplifier 2; 6. Voltage amplifier 2; 7. Voltage amplifier 1; 8. Power amplifier 1; 9. Laser; 10. Cylindrical surface; 11. Cylindrical lens; 12. Grating; 13. Oscilloscope

Three other figures show the operating principle of the space integration AO correlator, and pictures of correlation peaks between the radar signal and output. One table lists the experimental data.

LONGITUDINAL VIBRATION SYSTEM FOR ULTRASONIC POWER ACCUMULATION

[Article by Lin Zhongmao [2651 0112 5399] and Su Dunzhen [5685 2415 3791] of Institute of Acoustics, Chinese Academy of Sciences]

[Abstract] The paper studies a longitudinal vibration system for ultrasonic power accumulation; the system is driven by magnetostrictive transducers. The system block diagram is presented. Also studied are the effect on displacement oscillation amplitude at the system output terminal of the structural design, transverse dimensions of the acoustical waveguide, number of driving transducers, their installation sites, and input power. The experimental results are given. For a combined vibration system composed of four transducers, when the input power is 2.2 kW, nearly 300 μm of double vibration amplitude at $\emptyset$20mm output terminal is obtained. The ultrasonic system has been applied to cold drawn precision high pressure oil pipes with product precision up to the international level of West Germany DIN 7300A grade. To improve the electra-acoustic efficiency of the combined vibration system, the authors have begun experiments to replace magnetostrictive transducers with piezoelectric trans-ducers. Two figures show the combined vibration system and slotting on the acoustic waveguide. Four tables list various measurement data and the rela-tionship between the number of transducers and their installation sites, on the one hand, and the output terminal vibration amplitude, on the other. The paper was received for publication on 30 June 1984.

PRECISE ORIENTATION BY DIFFERENTIAL CORRELATION INTERPOLATION FOR DIGITAL SONAR SYSTEM

[Article by Dai Fuhe [2071 4395 0735] and Zhou Shiyuan [0719 0013 3293] of China Shipbuilding Industry General Corporation]

[Abstract] The paper discusses the central problem, the precise orientation problem, of multi-target real-time tracking by digital sonar system. Based on an analysis of the characteristics of differential correlated wave beams, an orientation method of applying two adjacent differential correlation wave beams is established; this method is the differential correlation interpolation orientation method. The paper presents very simple interpolation formulas, and calculates and analyzes the orientation characteristics applying the method. Computer simulation is used in the calculations. Four figures show the wave beam compensation, differential correlation output characteristics, response of two adjacent wave beams of the differential correlation interpolation orien-tation formula, and the orientation principle. Two tables list orientation

supplementary errors, and these orientation errors at different signal-to-noise ratios. The authors are grateful to the following persons: associate professor Yao Lan [1202 5695] of Harbin Marine Engineering College, and associate researcher Li Qihu [2621 0796 5706] of the Acoustics Institute, Chinese Academy of Sciences, for their advice; Dong Li [5516 4539] and Lu Xiaoyan [0712 2556 3601] for taking part in the computer calculations. The paper was received for publication on 26 March 1984.

Applied Math

LIQUID RESIDENCE TIME DISTRIBUTIONS AND MATHEMATICAL MODEL OF LARGE TRAYS

[English abstract of article by Yu Guocong [0151 0948 3827], et al., of the Chemical Engineering Research Center, Tianjin University]

[Text] The liquid residence time distributions (RTD) and flow pattern on two experimental sieve trays are studied by measuring the tracer response and using an on-line microcomputer for immediate data processing. The analysis of a large number of repeated RTD measurements indicates that the data obey the normal distribution law. Complicated mean RTD profiles on a single-pass tray and on a two-pass center downcomer tray are observed, but relatively uniform flow appears on the side downcomer tray.

The mathematical models for single-pass and two-pass trays based on liquid mean RTD profiles are developed to compute the liquid concentration profiles as well as the Murphree tray efficiency from point efficiency. The average deviation between the calculated plate efficiency and the experimental values found in the literature is less in the present model than in other existing models.

Finally, this paper demonstrates some new constructions for increasing the tray efficiency based on RTD improvement.

REFERENCES

[1] Murphree,E.V., Ind.Eng. Chem., 17,747 (1925)

[2] Bubble Tray Design Manual, Am. Inst. chem. Engrs., New York (1958)

[3] Diener, D.A., Ind. Eng. Chem., (Pro.Des.Dev.),6,499(1967)

[4] Кафаров,В.В., К.А.Алексадров,В.В. Шестопалов, Тео. Осн. Хим.Тех., No. 5, 781 (1969)

[5] Porter, K.E., M.J.Lockett, C.T.Lim, Trans. Instn. Chem. Engrs., 50,90 (1972)

[6] Brain, S., A.D.Freije,Trans, Instn. Chem.Engrs.,52,75(1974)

[7] Brambilla,A., Chem. Eng. Sci., No.7,517 (1976)

[8] Kafarov, V.V., V.V. Shestopalov, Y.A. Komissarov, I. Chem. E. Symposium Series, No.56, 2.3/79

[9] Yu, K.T. (余国琮), J.Huang (黄洁), F.J.Ku (顾芳珍), "Mathematical Modeling of Large Distillation Tray", paper Presented at the AIChE 88th National Meeting, Philadelphia (1980)

[10] 余国琮，黄洁，化工学报，[1]，11(1981)

[11] 余国琮，顾芳珍，化工学报，[2]，1(1981)

[12] Danckwerts, P.V., Chem. Eng. Sci., 2, 1 (1953)

[13] Foss, A,S,, J.A. Gerster, R, L. Pigford, AIChE. J,, 4,231 (1958)

[14] Sakata,M., Chem. Eng. Prog., 62,[11], 98(1966)

[15] Weiler,D.W., W.V.Delnicki, B.L.England, Chem. Eng prog.,. 69, [10], 67 (1973)

[16] Bell Richard L., AIChE. J., 18, [3], 491(1972)

[17] Bell Richard L., AIChE. J., 18, [3], 498(1972)

[18] 徐世民，天津大学申请硕士学位论文 (1985)

[19] Ostergaard,K., M.L.Michelsen, Can.J.Chem. Eng., 47,107 (1969)

[20] 张泽廷，天津大学硕士学位论文 (1982)

[21] Lockett, M.J., C.T.Lim., K.E.Porter, Trans. Instn. Chem. Engrs., 51, 61 (1973)

[22] Weiler, D.W., R.D. Kirhpatrick, M.J. Lockett, Chem.Eng.Prog., 77, 63 (1981)

A NOVEL METHOD FOR SOLVING CHANCE CONSTRAINED STOCHASTIC PROGRAMMING MODEL

[English abstract of article by Cai Yongxin [5591 3057 2450], et al., of the Institute of Systems Engineering, Tianjin University]

[Text] A novel method for solving a chance constrained model with a normal distributed righthand side (CNR) is studied. In connection with the key problems in solving this kind of model, a novel method combining the advantages of the number-theoretical method and the Monte-Carlo method--the number-theoretical Monte-Carlo method--for computing multivariate normal distribution functions with high efficiency has been proposed. With the GRG [generalized reduced gradient] linear programming to match, the number-theoretical Monte-Carlo method shows great advantages in optimization computation of CNR problems.

REFERENCES

[1] 蔡永新、刘豹，国家节能规划模型，天津大学硕士学位论文，1984

[2] 华罗庚、王元，数论在近似分析中的应用，科学出版社，1978

[3] A. Prékopa, Logarithmic concave measures with application to stochastic programming, Acta Sci. Math., 32(1971),301-316

[4] A. Prékopa, etc., The STABIL stochastic programming model and its experimental application to the electrical energy sector of the Hungarian economy, in Stochastic programming, M. Dempster (ed.), Proc. of the 1974 Oxford International Conference, Acad. Press, New York, 1980, 814-857

[5] J. Mayer, A nonlinear programming method for the solution of a stochastic programming model of A. Prékopa, in Survey of mathematical programming, A. Prékopa (ed.), North-Holland, 1982, 129-139

[6] I. Deak, Computation of multiple normal probabilities, in Recent results in stochastic programming, P. Kall and A. Prékopa (ed.), Springer-Verlag, Berlin, 1980,107-120

[7] O.L. Mangasarian, Pseado-Convex functions, SIAM J. on Control, Ser. A, 3(1965),281-290

[8] J. Abadie and J. Carpentier, Generalization of the Wolfe reduced gradient method to the case of nonlinear constraints, in Optimization, R. Fletcher (ed.), Academic Press, London, 1969, 37-48

Catalysis

STUDY OF SURFACE ACIDITY OF SYSTEMS $MoO_3/\gamma-Al_2O_3$ AND MoO_3/SiO_2

[English abstract of article by Zhao Biying [6392 3880 5391] and Kang Zhijun [1660 1807 6511], et al., of the Institute of Physical Chemistry, Beijing University]

[Text] The surface acidity of a series of $MoO_3/\gamma-Al_2O_3$ and MoO_3/SiO_2 was determined by the adsorption isotherms of n-butylamine on the samples in solution and by means of Hammett indicators. The results obtained by these two methods are consistent. As the MoO_3 content of the sample rises, the surface acidity increases and reaches its maximum, then no longer changes. The MoO_3 content of the sample at the turning point of acidity is very close to the monolayer dispersion threshold value obtained by XPS and X-ray quantitative phase analyses--this implies that the surface acidity depends on the surface concentration of MoO_3.

The mole ratio between the acid sites and MoO_3 dispersed on the surface is high and ranges from 0.5 to 1. This is a new conclusive evidence showing that MoO_3 is dispersed as a monolayer on the carriers' surface.

In addition, the surface acidity of pure MoO_3 was also measured. The results show about one acid site for each surface MoO_3 molecule. It is obvious that the surface acidity of the samples is caused by the dispersion of acidic oxide MoO_3 on the surfaces of the carriers and consequently the remarkable increase in its surface area. (Paper received 26 March 1984.)

REFERENCES

〔1〕 Massoth, F. E., *Adv. Catal.*, 27, 266(1978).
〔2〕 谢有畅,杨乃芳,刘英骏,唐有祺,中国科学(B辑),№8,673(1982).
〔3〕 刘英骏,谢有畅,唐有祺等,催化学报,3,262(1982).
〔4〕 桂琳琳,刘英骏,唐有祺等,中国科学(B辑),№6,509(1985).
〔5〕 北京大学化学系,石油化工科学研究院一室,石油炼制,№6,44(1977).
〔6〕 Ratnasamy, P., Sharma, D. K. & Sharma, L. D., *J. Phys. Chem.*, 78, 2069(1974).
〔7〕 Petrakis, L. & Kiviat, F. E., *ibid.*, 78, 2070(1974).
〔8〕 Maruyama, K., Hattori, H. & Tanabe K., *Bull. Chem. Soc. Japan*, 50, 86(1977).
〔9〕 赵璧英,康志军,李超,催化学报,6,65(1985).
〔10〕 复旦大学化学系催化组,石油化工,4,379(1975).
〔11〕 Deeba, M. & Hall, W. K., *J. Catal.*, 60, 417(1979).
〔12〕 赵璧英,吴念祖,桂琳琳,唐有祺等,中国科学(B辑)№8,704(1985).
〔13〕 Tanabe, K. et al., *Bull. Chem. Soc. Japan*, 47, 1064(1974).

STUDIES OF THE INTERACTION BETWEEN METAL AND SEMICONDUCTOR OF Pt/TiO₂ BY ELECTRIC CONDUCTIVITY AND INFRARED MEASUREMENTS

[English abstract of article by Hong Zupei [3163 4371 1014] and Hu Jiehan [5170 4105 3352], et al., of Dalian Institute of Chemical Physics, Chinese Academy of Sciences]

[Text] The metal and semiconductor interaction of Pt/TiO₂ was studied by electrical conductivity and IR spectrometric measurements. With the raising of H_2 treatment temperature, the electric conductivity of Pt/TiO₂ was increased, the intensity of adsorbed CO band was reduced and a remarkable "red shift" was found. It could be interpreted as a result of the negative charging of Pt due to the charge transfer occurring between the reduced TiO₂ and Pt. It is interesting to note that this red-shifted band could gradually be blue shifted and back to the original position with the prolonging of measuring time. The electrical conductivity of the untreated sample of Pt/TiO₂ was 10^{-9} Ω^{-1} at room temperature, while upon being treated with hydrogen at 174 and 374°C, the electrical conductivity rose to 10^{-3} and 10^{-2} Ω^{-1} respectively. For the sample reduced at 174°C, the admission of CO brought about the electric conductivity being increased by one order of magnitude, then decreasing very slowly. For the sample reduced at 374°C, CO admission caused the electric conductivity to drop first for about 20 min, then increase rapidly by about 3 orders of magnitude within 30 min, and finally remain constant for 18 hr.

The IR spectra (2094-2096 cm⁻¹) of adsorbed CO on untreated Pt/TiO₂ samples remained practically unchanged over a period of 8 hr. However, for the samples reduced in hydrogen, the strong bands of the IR spectra of adsorbed CO were shifted with time. After CO admission, for the sample reduced in hydrogen at 174°C, the strong band was at 2070 cm⁻¹ in 10 min, and shifted to 2075 cm⁻¹ after 2 hr, and 2083 cm⁻¹ after 13 hr. For the sample reduced at 374°C, the initial position of the strong band of adsorbed CO was at 2080 cm⁻¹, and shifted to 1083 cm⁻¹ in 2 hr. For the sample reduced at 174°C and then evacuated at 400°C for 4 hr, the initial position of the strong band of CO adsorbed was at 2095 cm⁻¹ and underwent only a little change for a period of 16 hr. This seems to be due to the reaction between the adsorbed CO and hydrogen, resulting in the back-spillover of protons from TiO₂, and consequently the back charge transfer from Pt to TiO₂. (Paper received 20 June 1983, and finalized 12 December 1984.)

REFERENCES

(1) Hu Jiehan, Hong Zupei et al. in "Studies in Surface Science and Catalysis", Elsevier, Amsterdam, Vol. 17, p. 53, 1983.

(2) Fujishima, A. & Honda, K., Nature (London), 233, 37(1972).

(3) Steven, N. F. & Bard, A. I., J. Amer. Chem. Soc., 99, 303(1977).

(4) Schrauzer, G. N. & Guth, T. D., ibid, 99, 789(1977).

(5) Tauster, S. J., Fung, S. C. & Garten R. L., ibid, 100, 170(1978).

(6) Tauster, S. J. & Fung, S. C., J. Catal., 55, 29(1978).

〔7〕 Wang Hongli, Xie Maosong, Wei Zhaobin et al., "China-Japan-USA Symposium on Heterogeneous Catalysis Related to Energy Problem", Dalian, China, Paper BC9C, 1982.

〔8〕 洪祖培, 陈怡萱等, 催化学报, **3**, 132(1982).

〔9〕 Herrmann, J. M., Disdier, J. & Pichat, P. in "Studies in Surface Science and Catalysis", (Eds. Imelik, B. et al.), Elsevier, Amsterdam, Vol. 11, p. 27, 1982.

〔10〕 谢茂松, 陶龙骧, 郭燮贤, 催化学报, **3**, 247(1982).

〔11〕 唐胜, 中国科学院大连化学物理研究所硕士论文, 1981.

〔12〕 Chen Yixuan, Wei Zhaobin, Chen Yanxin et al., *J. Mol. Catal.*, **21**, 275(1983).

〔13〕 田中胜己, White, J. M., 触媒(日), **24**, 252(1982).

〔14〕 Vannice, M. A., Twu, C. C. & Moon, S. H., *J. Catal.*, **79**, 70(1983).

〔15〕 Tanaka, K. & White, J. M., *ibid.*, **79**, 81(1983).

〔16〕 黄昆, 韩汝琦, "半导体物理基础", 科学出版社, p. 11, 1979.

〔17〕 Blyholder, G., *J. Phys. Chem.*, **68**, 2772(1964).

〔18〕 Horsley, J. A., *J. Amer. Chem. Soc.*, **101**, 2870(1979).

〔19〕 Bahl, M. K. et al., *Phys. Rev.*, **B21**, 1344(1980).

〔20〕 Vannice, M. A., Wang, S.-Y. & Moon, S. H., *J. Catal.*, **71**, 152(1981).

THE COKING BEHAVIOR OF ZEOLITE CATALYSTS DURING THE CONVERSION OF METHANOL TO LOWER OLEFINS

[English abstract of article by Liu Jinxiang [0491 6855 7449], et al., of Dalian Institute of Chemical Physics, Chinese Academy of Sciences]

[Text] The coking behavior of three kinds of zeolites with various pore structures in the reaction of the conversion of methanol to lower olefins has been investigated by means of thermogravimetry under the conditions of programmed increasing of temperature. The anticoking ability of ZSM-5 zeolites modified by loading with phosphorus, magnesium, manganese and zinc compounds, etc., has also been determined. It was found that the coking tendency on the zeolite in the reaction process mentioned above depended not only upon its pore structure, but also was related to the acidity of stronger acid sites of the zeolite. At the initial stage, the coking rate of the small pore zeolites was the highest, that of zeolites with large pores was in the middle, and the coking rate of the medium pore zeolites was the lowest. Their corresponding initial temperature regions of coke formation were 300-345°C, 320-410°C and 540-660°C respectively.

The anticoking abilities of ZSM-5 zeolites modified by phosphorus, magnesium and manganese were enhanced to varying degrees when compared with those of the original HZSM-5 zeolites, except for that of the zinc-modified one. This is because a part of the zeolite surface is occupied by the cations introduced, thus reducing the acidity of the stronger acid sites. The stability and selectivity of zeolite catalysts are evidently improved by modification, and the phosphorus and magnesium modified zeolites seem much more suitable for the needs of the conversion of methanol to lower olefins. (Paper received 6 January 1984.)

REFERENCES

〔1〕 祁庆生,现代化工,№4,24(1981).
〔2〕 Dejaifve, P., Auroux, A. et al., J. Catal., 70,123(1981).
〔3〕 U. S. 4,209,498.
〔4〕 Kaeding, W. W. & Butter, S. A., J. Catal., 61,155(1930).
〔5〕 田丸谦二著,朱传征等译,"动态多相催化",上海科学技术出版社,p. 125,1982.

KINETICS OF POLYMERIZATION OF ACETYLENE IN CATALYST SYSTEMS Nd(P₂O₄)₃/AlEt₃/THIRD COMPONENTS

[English abstract of article by Yu Luping [0205 7120 1627], et al., of the Department of Chemistry, Zhejiang University, Hangzhou]

[Text] The kinetics of the polymerization of acetylene in catalyst systems composed of $Nd(P_2O_4)_3$/AlEt₃/third component have been studied. The kinetic results show that the rate of polymerization R_p is proportional to the pressure of acetylene and the concentration of the catalyst respectively, i.e., $R_p = k'(cat)P$, where (cat) is the total concentration of the catalyst, P is the pressure of acetylene. It is found that the rate of polymerization declines as a function of reaction time in the secondary order, i.e., $R_p^{-1} = kt + R_i^{-1}$, where t is the reaction time and R_i is the initial rate of polymerization.

The experimental results obtained are explained by the hypothesis of the deactivation of active species according to a bimolecular process. The effects of different third components added to the binary catalyst system $Nd(P_2O_4)_3$/AlEt₃ are investigated. It is shown that the addition of P_2O_4 decreases the initial rate of polymerization, but retards the decline of the rate. The role of P is discussed. The polymerication temperature (T) affects both the rate of polymerization and the structure of polyacetylene. The effect of the polymerization temperature on the rate of polymerization is consistent with Arrhenius' equation and the activation energy, (E_p-E_H) is 2.55 Kcal/mol, where E_H is the activation energy of solubility of acetylene in toluene. (Paper received 9 November 1983, and finalized 20 March 1985.)

REFERENCES

〔1〕 Natta, G., Mazzanti, G. & Corradini, P., *Rend. Accad. Naz. Lincei*, 25(8), 3 (1958).
〔2〕 白川英树, 山边时雄编, "合成金属", 化学增刊, 第37卷, 1980.
〔3〕 Ito, T., Shirakawa, H. & Ikeda, S., *J. Polym. Sci., Polym. Chem. Ed.*, 12, 11(1974).
〔4〕 (a) Chiang, C. K. et al., *J. Chem. Soc., Chem. Commun.*, 16, 578(1977); (b) Chiang, C. K. et al., *Phys. Rev. Lett.*, 39, 1098(1977).
〔5〕 Shen, Z.-Q., Yang, M.-J., Cai, Y.-P. et al., *J. Polym. Sci., Polym. Lett. Ed.*, 20, 411(1982).
〔6〕 沈之荃, 杨慕杰, 蔡一平等, 中国科学(B辑), №2, 119(1983).
〔7〕 杨慕杰, 蔡一平等, 应用化学, 1, 79(1983).
〔8〕 杨慕杰, 蔡一平, 沈之荃, 中国稀土学报, 2, 8 (1984).
〔9〕 于广谦, 胡振亚, 高分子通讯, №6, 321(1980).
〔10〕 龚志, 李柏林等, 同上, №2, 116(1983).
〔11〕 欧阳均, 沈之荃编, "稀土络合催化合成橡胶文集", 科学出版社, p. 113, 1980.
〔12〕 Smith, W. E. & Zelmer, R. G., *Polym. Sci.*, A1, 2587(1963).
〔13〕 Haszeldine, R. N., Hyde, T. G. & Tait, P. J. T., *Polymer*, 14, 224(1973).

IDENTIFICATION OF A Si-Fe MOLECULAR SIEVE BY MÖSSBAUER SPECTROSCOPY

[English abstract of article by Ding Yingru [0002 3853 1172], et al., of the Department of Chemistry, Nanjing University]

[Text] Studying the replacement of Al and/or Si in a zeolite framework by other cations is interesting and promising zeolite research. The molecular sieve containing Fe made in our laboratory was analyzed by the X-ray diffraction method, and it was shown that its structure is similar to that of Mordenite. The Mössbauer spectrum of the said synthetic sample at room temperature shows a Fe^{3+} doublet. No large Fe_2O_3 particle could be found. In order to ascertain the iron actually located on the skeleton sites or located on cation exchangeable sites, a Fe^{3+} exchanged Mordenite was chosen to be compared with the synthetic sample. Under the same conditions, by exchanging Fe ions in the synthetic molecular sieve and exchanged Mordenite with H^+ ion separately, then taking their Mössbauer spectra, two different results were obtained. The spectrum of the synthetic sample showed the Fe^{3+} doublet, but no Fe could be detected for the H^+ exchanged Mordenite. It is known that hydrogen gas at elevated temperatures can reduce the exchanged Fe^{3+} in Mordenite to Fe^{2+}, but we really get two Fe^{2+} doublets. Fe^{3+} ions in the synthetic sample, however, are not reduced. Iron ions form covalent bonds with the oxygen framework, therefore it is possible to say that Fe^{3+} ions are located in the skeleton. The sample is really a new type of Si-Fe molecular sieve. (Paper received 9 May 1984.)

REFERENCES

(1) *Ger. Offen.* 2,831,611.
(2) *U. S.* 4,310,400.
(3) Delgass, W. N., Garten, R. L. & Boudart, M., *J. Chem. Phys.*, 50,4603(1969).
(4) Meier, W. M. Z., *Kristallogr. Kristallgeometrie, Kristallphys. Kristallchem.*, 115,439(1961).
(5) Wichterlová, B., *Zeolites*, 1,181(1981).
(6) Nováková, J. et al., *ibid.*, 2,17(1982).
(7) Garten, R. L., Delgass, W. N. & Boudart, M., *J. Catal.*, 18,90(1970).
(8) Beran, S., Jiru, P. & Wichterlová, B., *Zeolites*, 2,252(1982).
(9) Garten, R. L., Gallard-Nechtschein, J. & Boudart, M., *Ind. Eng. Chem. Fundam.*, 12,299 (1973).

MAGNETIC STUDY OF SYNTHETIC IRON-ZEOLITE CATALYST

[English abstract of article by Zhou Naifu [0719 0035 2105], et al., of the Department of Chemistry, East China Normal University, Shanghai; and Ding Yingru [0002 3853 1172], et al., of the Department of Chemistry, Nanjing University]

[Text] As reported previously, an iron-zeolite catalyst was synthesized and studied by XRD and Mössbauer spectroscopic methods. The sample was found to be of a mordenite-like structure and most of the Fe^{3+} ions were well disbributed in the skeleton of the crystal lattice.

In this paper, the magnetic study of both the synthetic Fe-zeolite sample and the Fe-exchanged mordenite sample is carried out using a Faraday magnetic balance. The following conclusions may be drawn from the measured magnetic parameters:
(1) For the synthetic Fe-zeolite, the value of the effective magnetic moment shows that most of the Fe^{3+} exists paramagnetically in a magnetic dilute state inside the lattice, while a very small portion of iron exists as γ-Fe_2O_3 and is located ferromagnetically on the sample's surface.
(2) In the acid-washing process, the ferromagnetic iron oxide of the synthetic sample was predominantly dissolved. When the sample underwent a hydrogen stream at 310°C for 1 hr, the paramagnetic Fe^{3+} did not display appreciable reduction.
(3) However, as for the sample of Fe-exchanged mordenite as shown by the lower value of the effective magnetic moment due to anti-ferromagnetic interaction between adjacent Fe^{3+} ions, the Fe^{3+} exists at the exchangeable surface sites, while a small portion of iron behaves ferromagnetically, indicating the multi-domains of γ-Fe_2O_3. (Paper received 9 May 1984.)

REFERENCES

[1] Chang, C. D., Lang, W. H. & Silvestri, A. J., J. Catal., 56, 268(1979).

[2] Caesar, P. D., Brennan, J. A. et al., ibid., 56, 274(1979).

[3] Rao, V. U. S., Gormely, R. J. et al., Preprints, Div. Fuel Chem., Amer. Chem. Soc., 25, 119 (1980).

[4] Lo, C., "Mössbauer and Magnetic Studies on Bifunctional Medium Pore Zeolite-Fe Catalysts Used in Synthesis of Gas Conversion", M. S. Thesis of Penn. State University, 1981.

[5] Mulay, L. N., Collins, D. W. & Fisher, Jr., W., Japan J. Appl. Phys., 6, 1342(1967).

[6] 丁莹如, 陶涛, 催化学报. 本期第280页.

[7] Hofer, L. J. E. in "Experimental Methods in Catalytic Research", (Anderson, R. B. Ed.), Academic Press, New York, 1968.

[8] Cullity, B. D., "Introduction to Magnetic Materials", Addison-Wesley, Reading, Mass., 1972.

[9] O'Connor, C. J. in "Progress in Inorganic Chemistry", (Ed. Lippard, S. J.), Wiley, New York, pp. 203—211, 1982.

[10] 周乃扶, 朱传征等, 化学学报, 42, 805(1984).

[11] Selwood, P. W., Ellis, M. & Wethington, K., J. Amer. Chem. Soc., 71, 2181(1949).

[12] Selwood, P. W., ibid., 70, 883(1948).

SYNTHESES OF SEVERAL NITROGEN-CONTAINING POLYMERIC LIGAND-BOUND CARBONYL RHODIUM CHLORIDE COMPLEXES AND THEIR CATALYTIC PROPERTIES FOR HYDROFORMYLATION OF DIISOBUTYLENE

[English abstract of article by He Binglin [0149 3521 2651], et al., of the Department of Chemistry, Nankai University, Tianjin; and Zhou Qizhao [0719 0796 2507], et al., of the Beijing Research Institute of Chemical Industry]

[Text] In order to prepare polymer-bound carbonyl rhodium chloride complex catalysts, 13 nitrogen-containing polymeric ligands, including poly-2-vinylpyridine, secondary amine resins, tertiary amine resins, quaternary base resin and chelate resins containint N, O donor atoms reacted with $Rh_2(CO)_4Cl_2$ separately. The catalysts were used to catalyze the hydroformylation reaction of diisobutylene. The catalystic activity and selectivity of the synthesized catalysts were examined.

By comparing the structure and catalytic properties of catalysts II-V and VI-VIII, it was found that the catalytic activity and selectivity of the complex catalysts with the same carrier, active components and donor atoms were obviously different, even with a slight change of the number and structure of the substituent on their donor atoms. In addition, it is worth noting that catalyst XI possesses not only very high catalytic activity, but also the highest selectivity for aldehyde formation.
(Paper received 27 March 1984.)

REFERENCES

(1) Greig, J. A. & Sherrington, D. C., *Polymer*, 19, 163(1978).
(2) *U. S.* 4,118,457.
(3) 何炳林等, 南开大学学报(化学专刊), 5, 103(1964).
(4) Pepper, K. W., Paisley, H. M. et al., *J. Chem. Soc.*, 4097(1953).
(5) 何炳林等, 高分子通讯, 3(4), 183(1959).
(6) Holy, N. L., 公开特许公报, 昭53—144,484.
(7) Pittman, C. U., Jr., Smith, L. R. & Hanes, R. M., *J. Amer. Chem. Soc.*, 97, 1742(1975).

STUDY OF THE REACTIVITY OF CHEMISORBED CO ON Rh/SiO$_2$ CATALYST

[English abstract of article by Zhong Shunhe [6988 7311 0735] of the Department of Chemical Engineering, Tianjin University]

[Text] The reactivities of chemisorbed CO with gaseous O$_2$, NO and H$_2$ over 1 wt percent Rh/SiO$_2$ catalyst have been investigated via infrared spectroscopy and temperature-programmed desorption methods. Three types of CO chemisorbed species, Rh(CO)$_2$ I, Rh(CO) II and Rh$_2$(CO) III, were found on silica-supported rhodium catalyst at room temperature. The reactivity of these species with O$_2$ or H$_2$ is in the order of I > II $\gg$ III. Chemisorbed CO can not react with gaseous NO, but species II can exchange with NO forming chemisorbed species Rh(NO) and RhO$_2$(NO) at the same sites. Comparing the spectrum of hydrogenation of absorbed CO with that obtained after H$_2$CO absorption and the coabsorption of the H$_2$ + CO mixture, it is clear that H$_2$CO is not relevant to the intermediates during hydrogenation of chemisorbed CO.

REFERENCES

[1] J.T.Yates, Jr., T. M. Duncan, S.D.Worley, and R.W.Vaughan, J. Chem. Phys., 70,1219(1979); 71,3908(1979)

[2] K.W.L.Watters, R.F.Howe, T.P.Chojnacki, C.M.Fu, R.L.Schneider, and N.B.Wong, J.Catal. 66,424(1980)

[3] C.A.Rice, .S.D.Worley, G.A.Mattson, C. W.Curtis, and J.A.Gurn, J.Chem.Phys.74,6487(1981)

[4] H.Arai and H.Tominaga,J.Catal. 43,131(1976)

[5] T.M.Apple and C.Dybowski, J.Catal. 71,316(1981)

[6] F.Solymosi and A.Erdohelyi, J.Catal.70,451(1981)

[7] T.Iizuka and Y.Tanaka,J.Catal.70. 449(1981)

[8] S.D.Worley and C.A.Rice, G.A. Mattson, C. W. Curtis, J.A.Guin, and A.R.Tarrer, J.Chem. phys.76(1),20(1982)

[9] S.L.T.Andersson and M.S.Scurrell,J. Catal.71,233(1981)

[10] S.D.Worley and C.A.Rice, G.A.Mattson, C.W.Curtis, J. A. Guin, and A.R.Tarrer, J.phys. chem.88(14),2714(1982)

[11] Zhong Shun-he and G. L. Haller, Journal of Tianjin Vniversity,No. 3, 101 (1985) .

CSO: 4009/1035

Data Processing

HIGH SPEED ANALYSIS OF POWER SPECTRUM OPTICAL-DIGITAL HYBRID SYSTEM

[English abstract of article by Sun Qichao [1327 0366 6389] and Yang Xuejun [2799 1331 3182], et al.]

[Text] This paper describes the principle of a high speed analysis of a power spectrum optical-digital hybrid system which is suitable for screening and processing a large number of patterns. In this paper the system is applied to recognizing lung cancer cells automatically.

REFERENCES

[1] G.G. Lendaris, G.L.stanley; «Diffraction – pattern Sampling for Automatic Pattern Recognition» Proc. IEEE 1970. Vol 58, No.2 p.198.

[2] Harvey L. Kasdan; «Optical power Spectrum Sampling and Algorithms» proc of SPIE 1977 Vol 117

[3] J.W Goodman; «Introduction to Fourier Optics» (McG raw.–Hill 1968)

[4] K.Fukunaga; «Introduction to Statistical Pattern Recognition» (Academic Press 1972)

[5] Jensen N; «High – speed Image Analysis Techniques» Photogrammetric Engineering Vol 39 1973

[6] 张以模，黄智：《利用功率谱作模式识别——以肺癌细胞筛选为例》光学学报 1984 Vol.4 No.4 p.368~373

DISTRIBUTION OF SIX BLOOD GROUP ANTIGENS IN BEIJING POPULATION

[English abstract of article by Hao Luping [6787 7216 5493], Zhang Zhi [1728 1807], Zhu Yuzhen [2612 3768 3791], and Sun Yun [1327 5366], et al., of the Beijing Red Cross Blood Center]

[Text] The distribution of six blood groups: Duffy, Diego, Kell, Ss, Lutheran, and Jacobs in Beijing population was investigated. Their gene frequencies were: Fy^a 0.9330, Di^a 0.0236, K 0.0022, k 0.9978, S 0.0394, s 0.9606, Jr^a 1.0000. While Kp^a, Kp^c, and Lu^a antigens were not found. (Paper received 30 March 1985, finalized 21 June 1985.)

TABLE

Blood types	Number studied	Phenotype	Residents of Beijing Frequency	Other frequencies			Amongst Beijing residents Gene frequency
				Whites	Blacks	Japanese	
Ss	1308	SS	4 (0.0031)	0.11	0.03	0.0096	S = 0.0394
		Ss	97 (0.0742)	0.44	0.28	0.1154	
		ss	1207 (0.9227)	0.45	0.69	0.8750	s = 0.9606
Duffy	669	Fy(a+)	666 (0.9955)	0.66	0.10	0.9890	Fy^a = 0.9330
		Fy(a-)	3 (0.0045)	0.34	0.90	0.0110	Fy^b = 0.0670
Diego	664	Di(a+)	31 (0.0467)	rare		0.0841	Di^a = 0.0236
		Di(a-)	633 (0.9533)	1.00		0.9159	Di^b = 0.9764
Kell	968	K+k-	0 (0.0000)	0.002	rare	0.0000	K = 0.0022
		K+k+	3 (0.0045)	0.08	0.02	0.0000	k = 0.9978
		K-k+	665 (0.9955)	0.91	0.98	1.0000	
	206	Kp(a+)	0 (0.0000)	0.02	rare		Kp^a = 0
		Kp(a-)	206 (1.0000)				
	361	Kp(c+)	0 (0.0000)				Kp^c = 0
		Kp(c-)	361 (1.0000)				
Lutheran	351	Lu(a+)	0 (0.0000)	0.0765			Lu^a = 0
		Lu(a-)	351 (1.0000)	0.9235			
Jacobs	655	Jr(a+)	655 (1.0000)				Jr^a = 1.0
		Jr(a-)	0 (0.0000)			0.0012	

REFERENCES

1. 袁义达等.华北汉族 Kell.Kidd.Diego.Duffy.Lutheran和Xg 血型系统的分布.遗传学报 1982；9：395.

2. 袁义达等．中国蒙族、朝鲜族和壮族8个红细胞血型和ABH分泌型系统的分布．中国科学院遗传研究所《研究工作年报》1982；96.

3. 袁义达等．侗族九个红细胞血型系统和ABH分泌型的分布.人类学学报 1984；3：278.

4. 赵桐茂．中国人Duffy 血型分布．中华血液学杂志 1982；3：323.

5. Race R R. Blood Group in Man. ed 6.Oxford: Blackwell Scientific Publication 1975；424.

6. Frances K ed al. Technical Manual of the American Association of Blood Bank. 8ed. Philadelphia: Publishen for the Association by J B. Lippincott Company 1981；146，149，150，151，154，158.

APPLICATION OF LiF:F_2^- CRYSTAL Q-SWITCH IN HIGH REPETITIVE YAG:Nd^{3+} LASERS

[Article by Zhang Guifen [1728 6311 5358] and Xu Shizhong [6079 0013 1813] of Shanghai Institute of Optics and Precision Instruments, Chinese Academy of Sciences]

[Abstract] Characteristics and experimental results of LiF:F_2^- crystal Q-switch in high repetition rate YAG:Nd^{3+} lasers are reported. These lasers have important applications in defense and scientific research. There is a series of advantages in using passive LiF:F_2^- color core crystal Q-switches; the authors obtained satisfactory results in low repetitive (1 to 2 times a second) operations. The paper also reports on F_2^- core stability and residual absorption of crystals. It is easy to achieve single, longitudinal mode operation with YAG:Nd^{3+} lasers; this is helpful to double-frequency and other types of experiments. Two figures show the experimental setup and laser waveforms. The paper was received for publication on 16 September 1985.

STUDY OF TRANSMISSION OF MODE-LOCKED SATURABLE ABSORBER BY STREAK CAMERA

[Article by Shi Ke [0670 3784], Xian Institute of Optics and Precision Instruments, Chinese Academy of Sciences]

[Abstract] The paper presents the effect of a saturable absorber on the operating characteristics of a mode-locked laser with a streak camera. The effects on the characteristics of laser threshold, pulse intensity and pulse width are given. Characteristics of the mode-locked saturable absorber are investigated analytically and the experimental results are in agreement with theoretical analysis. The streak camera can measure lock-mode pulse variable values at different transmission rates of the saturated absorber, and the relative laser intensity. Four figures show an experimental setup for a real-time study of laser pulse characteristics by use of a streak camera, laser pulses recorded by the streak camera, mode-locked pulse envelope recorded by a high-speed oscillograph, and YAG laser output pulse recorded by the streak camera system. The paper was received for publication on 26 September 1985.

SUPER-BROADENING STIMULATED SCATTERING IN LIQUID-FILLED WAVEGUIDE WITH LONG
GAIN LENGTH

[Article by Zhou Fuxin [0719 4395 2450], He Guangsheng [6378 0342 3932], Tang
Dingyuan [0781 1353 6678], Cao Zhuoliang [2580 0587 5328], Wang Runwen [3769
3387 2429] and Liu Songhao [0491 7317 6275] of Shanghai Institute of Optics
and Precision Instruments, Chinese Academy of Sciences]

[Abstract] Using an intense visible laser pulse to excite a liquid-filled
waveguide with a long gain length, the authors observed a new type of stimu-
lated scattering with superbroadening spectral width (> 500 cm^{-1}), which was
added to the sharp lines of stimulated Raman scattering (SRS) of Benzene or car-
bon disulfide. The liquid-filled waveguide system was designed by the authors.
Concerning the possible application of the long gain length liquid-filled wave-
guide system, the contradiction between the intensity of the focusing incident
laser in SRS and the effective gain length is removed; therefore, this system
can be used to measure the scattering signals in the weak Raman mode. One
table shows frequency shift range of stimulated scattering of benzene and the
central wavelength of SRS sharp lines. Two figures show the spectra of output
radiation of benzene and CS_2 core waveguides at different incident laser inten-
sities. The paper was received for publication on 23 November 1985.

REAL-TIME DETECTION OF DEFORMATION OF SOLID PRESSURE TRANSDUCER USING $LiNbO_3$:Fe
CRYSTAL

[Article by Tang Zesun [0781 3419 5549] and Huang Wenxiong [7806 2429 7160] of
Beijing Aeronautical Engineering College]

[Abstract] A solid pressure transducer is a pressure sensitive apparatus con-
verting pressure signals into electrical signals. The core portion of the trans-
ducer consists of a single crystal silicon cup and a Wheatstone bridge of four
equal-value resistances. The paper reports on a double exposure holographic
interference method for real-time detection of deformation of the solid pressure
transducer using a $LiNbO_3$:Fe crystal. The diametral-direction distribution of
membrane deflection of the solid state pressure transducer is obtained at various
pressure differences. The research will open new approaches to this type of
crystal used in real-time nondestructive testing. Three figures show the measure-
ment optical path, two-exposure holographic images, and comparison between
measured normal-direction displacement with the holographic interference method,
and the theoretical value of deflections (these two values are quite consistent
with each other). The authors are grateful to the Shanghai Institute of Silicate,
Chinese Academy of Sciences, for their providing the $LiNbO_3$;Fe crystal. The
paper was received for publication on 18 November 1985.

LASER OPTOACOUSTIC DETECTION TECHNIQUE WITH ACOUSTICALLY RESONANT-MULTIPASS OPTICS

[Article by Cai Bangwei [5591 6721 4850], Gu Xiujuan [7357 4423 1227] and Zhao Wen [6392 2429] of Department of Physics, Sichuan University]

[Abstract] The paper reports on new acoustically resonant multipass cell combining Herriott optics with a high sensitivity optacoustic detection technique. Using a 5 W CO_2 laser as a source, the authors determined microphone output voltage as a function of the relative concentrations of CO_2, C_2H_4 and SF_6 in N_2, respectively. The minimum detectable sensitivity is 0.06 ppb (6×10^{-11}); this is an improvement by two to three orders of magnitude compared with the sensitivity obtained in a nonresonant single pass cell. The multipass optoacoustic cell is shows in the following figure:
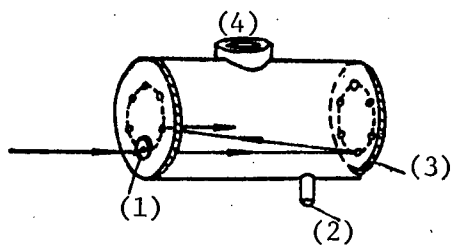
Key: 1. Incident infrared window opening; 2. To gas suction and filling system; 3. Concave reflective mirror; 4. Microphone.

Five other figures show a laser optoacoustic detection layout with acoustically resonant-multipass optics, computer-drawn optical path and experimental results, and relationships between optoacoustic signal, on the one hand, and concentrations of CO_2, C_2H_4 and SF_6, on the other. One table shows some data of calculated $\alpha_{m \cdot n}$, the solution of Bessel's equation, of the cylindrical optoacoustic chamber. The authors are grateful to Lu Yucun [4151 3768 2625] for coating the highly reflective membrane. The paper was received for publication on 17 October 1985.

Nuclear Physics

SOME STUDIES OF PICTORIAL DRIFT CHAMBER MODEL

[English abstract of article by Ding Huiliang [0002 1979 5328], et al., of
the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] A pictorial drift chamber model has been constructed. The associated
readout circuit of the model chamber is made with the capability of recording
eight hit events. The present study was undertaken to investigate the
properties of the chamber, including spatial and double track resolutions,
resolution of left/right ambiguity as well as pattern recognition of multi-
track events. In this paper, the construction of the model chamber is
briefly described. Also described are the principle and the block diagram
of the readout cirtuit, the properties of each unit and the properties of the
whole circuit. The experimental results reported here include X-spatial
resolution (σ_x = 280 m), Z-spatial resolution (σ_z = 3 cm), and the recon-
structed track picture of a cosmic ray shower.

MEAN FIELD STUDY AND UNIVERSALITY IN LATTICE GAUGE THEORY

[English abstract of article by Li Wenzhu [2621 2429 6999], et al., of Zhejiang University]

[Text] We have studied Manton's action and several other actions in lattice gauge theory with the naive mean field approximation method and the method proposed by Shahbazyan. Values of β at the crossover point are obtained with different kinds of SU(2) actions by using both the mean field approximation method and the method proposed by Shahbazyan. In the latter case, universality is assumed and the Monte Carlo results of the SU(2) Wilson action and the relationships between the Wilson action and other actions are taken as input. The results of the two methods are compared and the universality assumption is checked.

IMPROVEMENTS TO THE BEPC STORAGE RING LATTICE

[English abstract of article by Fang Shouxian [2455 1344 6343] and Chen Limin [7115 0448 3046], et al., of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] The principles and results of improving the BEPC storage ring lattice are described. The minimum β_y^* is chosen to be 0.08 m so that the design luminosity reaches 2×10^{31} cm$^{-2} \cdot$s^{-1}. Increasing the ratio β_x^*/β_y^*, the required aperture of insertion quadrupoles as well as the horizontal chromatic aberrations are reduced. A trunk with more variables of Q_F strength is adopted to provide better dispersion suppression and smaller β function and modulation, attaining a dynamic aperture of $12\sigma_x \times 12\sigma_y \times 12\sigma_E$. The phase advance between two major kickers is changed to be close to 180° in order to simplify the injection system. Four straight sections where dispersion D_x is large are provided to place emittance control wigglers and four other straight sections near to the zero dispersion regions will be useful for synchrotron radiation applications.

MEASUREMENTS OF MIXED RADIATION FIELD AROUND A PROTON LINAC

[English abstract of article by Tang Esheng [0781 6759 3932] and Li Jianping [2621 1696 1627], et al., of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] The radiation field around a high energy accelerator is a pulsed mixed radiation field of complex particle constituents. The distribution of the radiation field around a 10 MeV proton Linac in commission is measured with a three detector system. The absorbed dose and dose equivalent of both the neutrons and γ-rays in the Linac hall are measured. The average quality factor of the mixed radiation field is given. The results and uncertainty of the measurements are analyzed and discussed.

THE R(π/2) INVARIANCE OF NUCLEI

[English abstract of article by Gu Jinnan [7357 6855 0589] of the Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou]

[Text] For the nuclear deformation of $\lambda = 2, 4, 6, \ldots$, the most important symmetries are axial symmetry and R(π) invariance, but there is probably R(π/2) invariance in some nuclei. In this paper the possible occurrence of this new symmetry is analyzed in general. In particular, the conditions for the existence of the R(π/2) invariance, wave functions of a nucleus with R(π/2) invariance and signature-dependent terms in the matrix elements of an operator F are discussed in detail. These provide an analysis of the experimental data, for example, the alternating behavior of level energies and B(E2) for $K^\pi = 0^+$ and $K^\pi = 0^-$ bands.

Optics

EXPERIMENTAL STUDY OF COLLIDING PULSE MODE LOCKING OF A Nd:YAG LASER

[English abstract of article by Liu Yixian [0491 0001 0341] and Ma Haiming [7456 3189 2494], et al., of the Department of Physics, Fudan University, Shanghai]

[Text] In this paper, an experimental set-up of a colliding pulse mode locking of a Nd:YAG laser is reported. The effect of various parameters on the characteristics of the colliding pulse mode-locking has been investigated. Under optimal conditions, the shortest pulse duration of 8ps was obtained and the stability of the output energy was about ±7 percent.
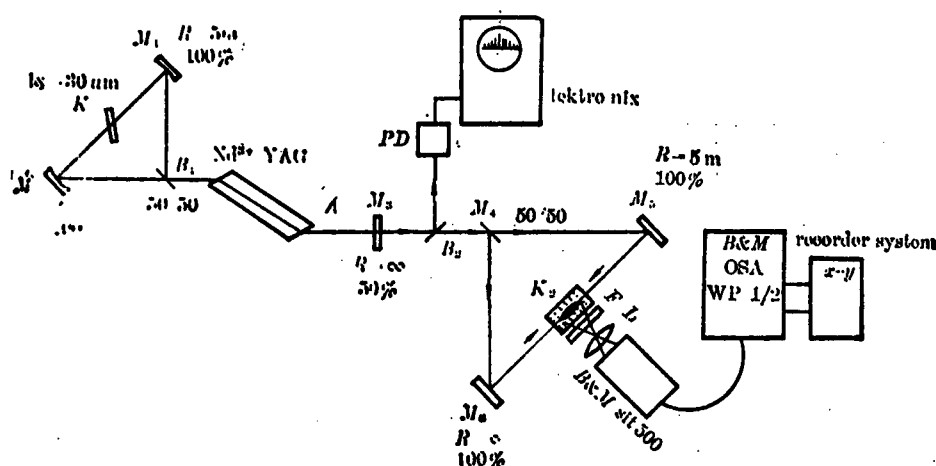

Fig. 1 Schematic diagram of the experimental arrangement

OPTICAL RESONANT REFLECTORS AND THEIR APPLICATION IN LASER TECHNIQUES

[English abstract of article by Zhu Zhimin [2612 2535 2404], Chen Shaohe
[7115 4801 0735] and Chen Qinghao [7115 1987 3185], et al., of the Shanghai
Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] Reflection spectra of resonant reflectors have been solved on a
computer. They can be divided into two types: degenerate and non-degenerate.
Line shapes of resonant peaks, modulability of envelopes, characteristics of
periodic spectra and two relevant properties are discussed in detail. The
single axial mode operation in a tuning range of 2$\overset{\circ}{A}$ has been obtained with
a PZT tuned resonant reflector. This work provides a background for designing
resonant reflectors.

STIMULATED EMISSION BASED ON TWO-STEP HYBRID RESONANCE VIA $A^1\Sigma_u$ OR $B^1\Pi_u$ STATE OF Na_2*

[English abstract of article by Qin Lijuan [4440 5461 1227] and Zhang Kechang [1728 7030 2490], et al., of the Department of Physics, East China Normal University, Shanghai]

[Text] Stimulated emission based on two-step hybrid resonance via $A^1\Sigma_u$ or $B^1\Pi_u$ state of Na_2 has been observed using broad-band and narrow-band dye lasers as pumping sources. The mechanism is discussed.
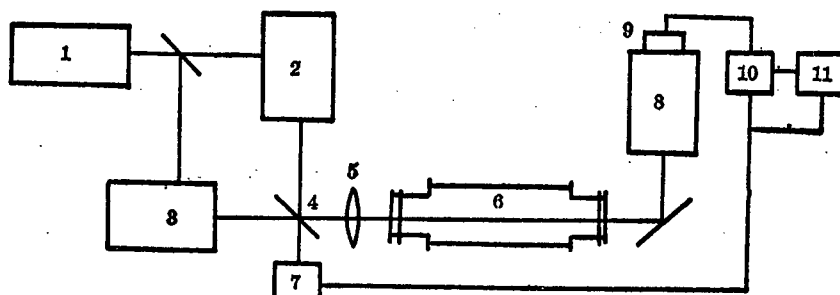

Fig. 1 Experimental setup

1—N_2 laser; *2*—broadband dye laser; *3*—narrowband dye laser; *4*—splitter; *5*—lens; *6*—heat-pipe oven; *7*—triggering detector; *8*—grating monochrometer; *9*—infrared detector; *10*—signal processing system; *11*—oscilloscope or chart recorder

EXACT ANALYTIC SOLUTIONS OF HIGH-ORDER GAUSSIAN BEAM MODES IN MEDIA WITH QUADRATIC RADIAL REFRACTIVE INDEX AND GAIN PROFILES

[English abstract of article by Zhang Ruilin [1728 3843 2651] of the Department of Physics, Nankai University, Tianjin]

[Text] The exact analytic and steady-state solutions are derived for high-order Gaussian beam propagation modes in media with quadratic radial refractive index and gain (loss) profiles based on the slowly varying envelope approximation (SVEA). Explicit expressions of the solutions are given for some useful specific cases. Possible applications of the present theory to optical cavities and waveguides with such media and to problems of optical bistability in cavities having media with quadratic radial index and absorption profile are discussed.

SPECTRAL AND LASING CHARACTERISTICS OF PBD SERIES OF UV LASER DYES

[English abstract of article by Shao Ziwen [6730 1311 2429], et al., of the Shanghai Institute of Laser Technology; Pan Jiaxing [3382 1367 2622] and Zhou Yimin [0719 0001 3046], et al., of the Department of Chemistry, Nankai University, Tianjin]

[Text] This paper describes the characteristics of six laser dyes of PBD series which are compounds of 2-phenyl- and five of 2-(p- or m-substituted phenyl)-5-(4'-biphenyl) oxadiazoles. Two of them are new compounds that were synthesized by Nankai University. The ultraviolet absorption spectra, fluorescence spectra and fluorescence quantum yields of such dyes are given. Tuning curves of PBD dye lasers pumped by a nitrogen laser are measured, and the tunable spectral regions are found to be of 356 to 393 nm. The laser conversion efficiencies of all six PBD dyes reported here are higher than those of existing laser dyes of PPO and BPBD. The PBD series dyes are suitable for pumping by either the N_2 laser (377 nm) or XeCl excimer laser (308 nm).

9717
CSO: 4009/56

NONLINEAR DISTORTION OF ULTRASONIC PROPAGATION IN SOLIDS

[Article by Wang Yaojun [3769 5069 0193], Institute of Acoustics, Nanjing University]

[Abstract] In studying ultrasonic propagation in solids, generally the linear approximation method is used, neglecting the second-level smaller values of sound-wave parameters, such as displacement, strain and stress with an assumption that the relation between stress and strain obeys Hook's Law. However, for higher-intensity sound waves propagated in solids, stress and strain cannot be described by Hook's Law as nonlinear factors of particle vibration should be preserved. From the propagation characteristics of waves, the original vibration of simple harmonic fundamental waves will produce higher-order components of harmonic waves, leading to waveform distortions. The general form of nonlinear wave equations in anisotropic crystals is quite complex, therefore it is very difficult to write the analytical expression of the solution; an electronic computer must be used to obtain the numerical solution. For propagation sound waves along some special direction of isotropic solid and cubic crystals, however, if only considering the smaller second-level values of parameters, the form satisfying nonlinear equations and their solutions is not complex. Starting from these equations, common regularities of ultrasonic nonlinear propagation can be understood.

EDGE DISLOCATIONS ACTING AS STEP SOURCES FOR CRYSTAL GROWTH

[Article by Liu Guangzhao [0491 0342 3564], Shanghai Institute of Silicate, Chinese Academy of Sciences]

[Abstract] Before answering the question, "Can edge dislocations act as step sources for crystal growth," the basic view prevails is that growth steps should exist on crystal faces. E. Bauser first observed growth steps on closely packed planes of GaAs at the extension of the liquid phase; her experiment came to be referred to as a major finding that edge dislocations can act as step sources for crystal growth. E. Bauser and H. Strunk used electron microscopes to examine the extension layer of GaAs with studies stressed on three tetrahedra. They discovered that each growth cone is linked to a dislocation and finally proved that edge dislocations can be step sources for crystal growth. Generally, steps are formed into enclosed concentric rings. At present, further studies are underway.

PHYSICAL POLLUTION IN ENVIRONMENT AND ITS ABATEMENT

[Article by Fang Danqun [2455 0030 5028], Chen Qian [7115 3383] and Zhao Yufeng [6392 3768 1496] of Research Center of Environment Physical Pollution Control, Beijing Institute of Labor Protection Science, Chinese Academy of Environmental Sciences]

[Abstract] In the environment, physical pollution appears in the following forms: noise, vibration, light and radioactivity, as well as water, atmosphere and dust. According to investigations, more than one-quarter of China's industrial workers are exposed to a noise level exceeding the norms covered by the health code. Some 100 to 200 million residents live in an environment with noise levels in excess of the norms. As for electromagnetic radiation, 40 percent of the western region of Beijing and 29 percent of the entire city of Changsha are exposed to pollution. The phenomenon of heat islands exists in Beijing, Shanghai and Hangzhou with temperatures 0.1 to 1.5°C higher than the surrounding countryside. This results in more cloudiness and precipitation in the cities. More than 12 million tons of cooling water are discharged into the environment every day from China's thermal power plants. The article proposed pollution control with satisfactory laws and norms, pollution prevention in urban and industrial built-up areas, research on low-pollution products, noise abatement for aircraft, trains and vessels, as well as education of population on pollution control. One figure shows noise level classification of 10 categories of industry. One table lists decibel data in 31 Chinese cities.

ELECTRON DENSITY MEASUREMENT WITH AN HCN LASER ON CT-6B TOKAMAK

[Article by Li Wenlai [2621 2429 5490] and Xu Yougang [1776 0645 0474] of Institute of Physics, Chinese Academy of Sciences, and Guo Qiliang [6753 0366 5328] and Tong Xingde [4547 5281 1795] of Hefei Institute of Plasma, Chinese Academy of Sciences]

[Abstract] Only the average electron density of plasma in a CT-6B Tokamak was obtained with an HCN laser, which is 2.5 m long, 5 cm in internal diameter, 337 um as the operating wavelength, and about 20 mW in output power. The output principal mode is the EH_{11} mode and the vector of electric field is linear polarization. Considering that the polarization direction of the electric field of light must be parallel to the ring-shaped Tokamak magnetic field, the polarization direction of the laser output light beam is fixed at a horizontal direction. One of three figures shows the optical path; a Mach-Zehnder type interferometer is used. The second figure shows the signal processing procedure, and the last figure shows waveforms of the electron line density of Plasma from a CT-6B Tokamak apparatus. The research was supported by the Section No 102, Institute of Physics, Chinese Academy of Sciences. The authors are grateful to the following persons: Xie Anyun [6200 1344 7189], Qiao Fuhuang [0829 3940 4106] and Ma Mingyi [7456 2494 5030] for their assistance, and Dr D. Veron of France for his advice.

ORGANIC SUPERCONDUCTORS

[Article by Zhu Daoben [2612 6670 2609], Institute of Chemistry, Chinese Academy of Sciences]

[Abstract] Whether or not molecule crystals of organic compounds can exhibit superconductivity was a disputed problem for many years. In 1980, Jerome et al. eventually discovered that superconductivity appears in $(TMTSF)_2 \cdot PF_6$ at 0.9K and a static pressure of 12 kbar. As is well known, there are two basic phenomena of a superconductor: the transition from the limited electric resistance state (normal state) to the zero resistance state (superconducting state), and an external magnetic field unable to penetrate the superconductor. In addition, abrupt changes in other characteristics will occur at the critical temperature T_c: specific heat, thermo-electromotive force, Hall effect and infrared absorption, among others. Very rapid progress has been reported in the recent four years on the study of superconductors. In addition to $(TMTSF)_2 \cdot PF_6$, 9 other organic conductors were discovered as shown in a table given in the text. Among 10 organic superconductors so far discovered, 7 are $(TMTSF)_2 \cdot X$ molecule crystals, and 3 are $(BEDT-TTF)_x \cdot X_y$ salts. Five figures show the zero resistance state, critical magnetic field, relationship between critical pressure and cell parameter at room temperature and normal pressure, parameters of organic superconductor and dV/dI characteristic. The author is grateful to Qian Renyuan [6929 0086 0337] for his counsel.

REAL-TIME PROCESSING OF MICROWAVE INTERFERING SIGNALS IN TOKAMAK

[Article by Zheng Shaobai [6774 1421 4101], Yang Xuanzong [2799 1357 1350], Liu Yiqun [0491 6522 5028] and Cui Binsheng [1508 3453 3932] of Institute of Physics, Chinese Academy of Sciences]

[Abstract] A microwave moving streak interferometer can be used to measure plasma density and distribution; the interferometer is a very useful diagnosis device for high-temperature plasma. Generally, a zebra diagram of interference streaks is used to show variation in plasma electron density, but not the electron density. As discovered in experiments, a fairly complex perturbation structure can be obtained from the microwave interference signal such as no simulation experiment can achieve. Therefore, the authors designed a special computer collection system. Thus, not only can zebra signals be collected in clarifying the perturbation structure of interfering signals, but also logic flow and dynamic testing conditions can be provided for designing a real-time processing system. Based on experimental data of computer processing, a real-time processing system was designed with satisfactory results obtained in experiments. Three figures show the computer collection system, its program flowchart, the zebra diagram, and the real-time processing result.

FUNDAMENTALS OF MOS PHYSICS

[Article by Shi Changxin [0670 1603 1823], Department of Applied Physics, Jiaotong University, Shanghai]

[Abstract] Used as metal-oxide-semiconductor field effect transistor (MOSFET), the MOS (metal-oxide-semiconductor) system plays a key role in VLIC (very large integrated circuits), the MOS is also one important means of studying semiconductor devices, materials and techniques. Starting from integrated circuits (IC), the article stresses the introduction of fundamentals concerning the electric characteristics of the MOS system. Presentations are conducted in the following sequence: space charge zone at semiconductor surface, characteristics of capacitance-versus-voltage and conductance-versus-voltage in MOS system, and electron trap in silicon dioxide. One table lists data on surface situation of p- and n-type substrates. Ten figures show the energy belt near the semiconductor surface, curves of F function, curves of space charge-versus-voltage, surface potential distribution, calculation example of n-type germanium, quasi-Fermi energy level of electrons and holes, energy zone with bias voltage existing between the surface reaction layer and substrate, relationship between ideal MOS unitary capacitance and grid voltage of a p-type substrate, electric conductance effect induced by the boundary surface state energy, and energy zone of MOS structure at the flat belt.

APPLICATION OF DEGENERATE FOUR-WAVE MIXING IN ATOMIC AND MOLECULAR SPECTROSCOPY

[Article by Fu Panming [0265 4149 6900], Physics Institute, Chinese Academy of Sciences]

[Abstract] Degenerate four-wave mixing has been one of the major interesting problems in recent years mainly because of the generation of a phase conjugate wave, reverse to the wavefront of the incident wave. Thus, aberration of light while propagating in the system can be eliminated. Another important usage of degenerate four-wave mixing is its use as a means of spectroscopy by producing a high-discriminability spectrum in an atomic or molecular system to eliminate the Doppler effect. The paper presents this kind of spectrum. Eight figures show the mechanism of degenerate four-wave mixing, resonant enhancement due to interaction between incident light and matter, the frequency mixing signal as the result of bunch grating diffraction, a standard experimental layout, and a relation between incident light frequency and intensity of the mixing-frequency signal produced by skips, phusical regime of double-photon degenerate four-wave mixing (and its transient-state process), and a relation between delay time and intensity of mixing-frequency signal.

GETTERING TECHNOLOGY

[Article by Zong Xiangfu [1350 4382 4395], Material Science Institute, Fudan University]

[Abstract] Even single crystals free of dislocations may have oversaturation defects and contamination (from processing during crystal growth and manufacture), causing aggregation of heavy metal atoms as microdefects in dimensions of the micrometer and sub-micrometer levels shown in the only table given in the paper. A study of micro-defect control and impurity gettering provides an important basis for developing LSI and VLSI production. In various gettering techniques, interactions of impurity--impurity, impurity--defect, and defect--defect are employed to control

the introduction of point defects. Additionally, metal impurities are accumulated in the non-electro-active zone of the silicon chip in order to reduce or eliminate their damage. There are quite a number of gettering techniques: phosphorus and boron gettering, back-damage gettering, stress-membrane gettering, chlorine gettering, polymorphous gettering, and oxygen intrinsic gettering, among others. The paper presents their methods, effects and mechanisms. Eight figures show the distribution of heavy metal impurities in the phosphorus diffusion layer, gettering effects at different temperatures, silicon chip surface grinding viewed as carving with grinding particles, the gettering effect following heat treatment at different temperatures after Ar ions were injected to the silicon chip, distribution (with depth) of oxidation surface layer dislocations, its length variation caused by different amounts of HCl blended, as well as profile distributions of disclocations and gold concentrations.

SYNTHESIS OF DIAMOND THIN FILMS BY ION TECHNIQUES

[Article by Guo Huacong [6753 5478 5115], Institute of Atomic Nucleus Science and Technology, Sichuan University]

[Abstract] Synthesized by an ion technique, the diamond thin film (i-C film) has a number of outstanding characteristics: high insulation, negative temperature coefficient in electrical conductivity, high dielectric strength, value of dielectric constant between 8 and 12, relatively high hardness, relatively high optical transmission, large band gap (1-2.6 eVO, capability of blended into n or p type material, chemical inertness against acid and organic solvent, value of refractive index at 2-2.8, and density about 2 g/cm^3. The paper briefly presents the synthesis method, characteristics, formation mechanism, and applicability of the i-C film. Magnetic fields have been used on ion coatings with an apparatus as shown in the following diagram.
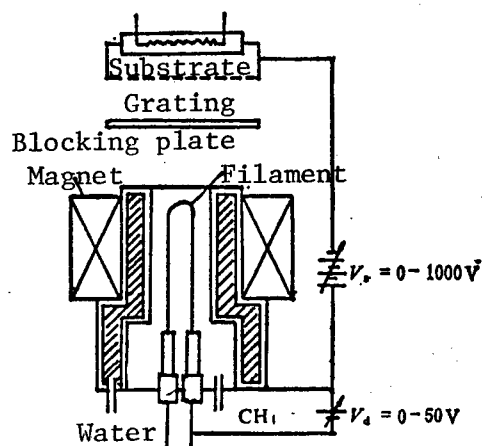

Figure 1

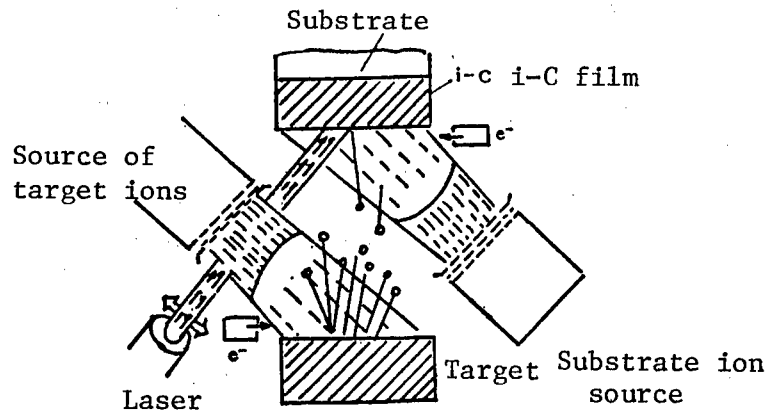Second figure shows an apparatus of ion beam spattering deposit.

Figure 2

The spattered carbon ions are deposited on the substrate as the i-C film.
The third (and also the last) figure shows the relationship between hardness
of i-C film and bias of the substrate.

EXCITATION OF HIGH FREQUENCY PHONONS IN SOLID STATE

[Article by Pai Yuhai [4101 3768 3189] and Pei Liwei [5952 0500 0251],
Acoustics Institute, Chinese Academy of Sciences]

[Abstract] Phonons are very active quasi-particles in solid state physics.
The frequencies of acoustical phonons range from 10^9 Hz to 10^{12} or even
10^{13} Hz; the highest frequency is determined by the crystal lattice
structure. Phonons with a frequency of 10^9-10^{11} Hz is called microwave
phonons. The most common method in producing and testing microwave
phonons is electromagnetic excitation of piezoelectric crystals. The
paper briefly presents several experimental techniques of exciting phonons,
and applications in physical research. There are excitations (of phonons)
with thermal pulse and superconductive tunnel junction, as well as optical
excitation with high-frequency phonons. One table lists data on super-
conductive materials usually used in phonon experiments. Seven figures
show thermal phonon radiation spectrum of copper alloy thin film, a phonon
experiment with thermal pulses, superconductive tunnel junction as the
source of high-frequency phonons, a phonon fluorescence experiment and
phonon emission spectrum, high-frequency coherent phonons produced with
far infrared surface excitation, testing and exciting high-frequency
phonons with Cr^{3+} in ruby, and the phonon transient spectrum in CaF_2
crystals.

INFLUENCE OF O_2 ON THE ELECTRONIC STRUCTURE OF CLEAN AND ION SPUTTERED SURFACES OF 2H-MoS$_2$(0001)

[English abstract of article by Hu Yongjun [5170 3057 6511] and Lin Zhangda [2651 1757 6671], et al., of the Institute of Physics, Chinese Academy of Sciences]

[Text] UPS, XPS, AES and LEED have been applied to study the samples prepared by low energy N$^+$ (0.5 keV) slightly sputtering the clean cleaved surface of 2H-MoS$_2$(0001). From UPS (He I, He II) spectra, shifts of E_F of the d band were observed. A "shoulder" or a band tail above the top of the d_{z2} band rose with the time of ion bombardment so that the shape of the d_{z2} band became broad. The new state was chemically active to O_2 exposure at room temperature. We propose that these shoulder states arise from the new unsaturated bonding d-electrons of Mo atoms around the vacancies of S at the outermost layer of the surface. This new surface electronic state may be correlated with the catalysis active site for hydrodesulfurization (HDS).

STUDIES OF WC ELECTRON STRUCTURE AND MAGNETISM

[English abstract of article by Lin Zhangda [2651 1757 6671] and Wang Changheng [3769 2490 5899], et al., of the Institute of Physics, Chinese Academy of Sciences]

[Text] UV-photoelectron spectroscopy (UPS) and X-ray photoelectron spectroscopy (XPS) were used to study the electronic structure of WC, Pt and W, and a highly sensitive magnetometer was employed to measure the temperature dependence and field dependence of magnetic susceptibility of WC and W in the temperature range of 1.5-300 K. The susceptibility of W did not change with temperature, exhibiting the behavior of Pauliparamagnetism. But the behavior of WC was entirely different, following Curie's law. Because unpaired spins exist in WC, we present the following hypothesis: Due to the influence of carbon in WC, 5d electrons of W are no longer thoroughly itinerent. Like those of Pt, some of the valence electrons become localized. The appearance of localized electrons in WC is the cause of the platinum-like catalytic activity.

RENORMALIZATION GROUP STUDY OF ORDER-DISORDER TRANSITIONS IN THE W(112)p(2x1)-O SYSTEM

[English abstract of article by Zhao Lihua [6392 4539 5478] of the Department of Physics, Hunan University, Changsha; and Feng Kean [7458 0344 1344] and Wu Naijuan [0124 0035 1227] of the Institute of Physics, Chinese Academy of Sciences]

[Text] The position-space renormalization group method is employed to investigate the order-disorder transitions in the W(112)p(2x1)-O system. The recursion relationships are based on the periodically continuing cluster of four cells with four sites each. We have studied the pairwise interactions between the nearest and next-nearest neighbors as well as the three-particle and four-particle interactions, and have formulated the relationships between the renormalized coupling parameters K'_α and interaction constants K_α. From the renormalization iteration we have found the fixed point K^*_α and the critical temperature T_c for various monolayer coverages. The phase diagram of the W(112)p(2x1)-O overlayer obtained is found to be in agreement with the existing experimental results.

ORIENTATION DEPENDENCE OF OXYGEN ADSORPTION ON SILICON SURFACES

[English abstract of article by Xing Yirong [6717 4135 2837] of the Institute
of Semiconductors, Chinese Academy of Sciences; and W. Ranke of Fritz-Haber-
Institute der, Max-Planck-Gesellschaft, Berlin, West Germany]

[Text] AES and photoelectron spectra obtained with synchrotron radiation have
been used to study the orientation dependence of oxygen adsorption on a
cylindrical Si single crystal. At 350 K for ~2L exposures, the results
revealed that the orientation dependence of the adsorption oxygen amount is
comparatively weak, and it can be understood in terms of step-enhanced
adsorption. At intermediate exposures of ~10L, the penetration of oxygen
atoms into the crystal lattice was found mainly on (111) orientation. This
fact supports a "defect"-type model for the Si(111)-(7x7) reconstruction.

INFLUENCE OF IN-PLANE FIELDS ON FORMATION OF HARD BUBBLES

[English abstract of article by Han Baoshan [7281 1405 0810], et al., of the
Institute of Physics, Chinese Academy of Sciences; and Nie Xiangfu [5119 0686
1381], et al., of the Department of Physics, Hebei Teacher's University,
Shijiazhuang]

[Text] The influence of in-plane fields on the formation of hard bubbles in
epitaxial garnet films using a single-pulse bias field was investigated in
some detail. A critical in-plane field H_{in}^0, which is related to the bubble
film parameters, was discovered. When $H_{in} > H_{in}^0$, formation of hard bubbles
no longer occurs. Three physical processes, i.e., increase, quick decrease
and slow decrease of the demarcation field for soft and hard bubble formation
$H_{[b]}$ with in-plane fields, can be qualitatively interpreted in terms of the
effect of the in-plane field on stripe domains, as well as the formation of
multifingered domains.

DIFFRACTION PATTERNS PRODUCED BY A LASER BEAM PASSING THROUGH POTASSIUM IODATE CRYSTALS AND THEIR DEPENDENCE ON PHASE TRANSITIONS

[English abstract of article by Wang Xiu [3769 3811], et al., of the Department of Physics, Sichuan University, Chengdu; and Lu Mengkai [0712 1322 0418] of the Institute of Crystal Materials, Shandong University, Jinan]

[Text] In this paper, the diffraction bands and spots experimentally observed when a laser beam passed through a KIO_3 single crystal are reported. The bands and spots are formed by the diffracted beam, the polarization plane of which rotates 90° with respect to that of the incident beam. The temperature dependence of the diffracted light was investigated from room temperature to 240°C. It was found that when T = 72°C the intensity increased abruptly, when T = 212°C it decreased to almost zero, and when T > 212°C no diffracted light was observed. The two temperatures, 72°C and 212°C, determined from the anomaly of the intensity dependence, are in good agreement with the KIO_3 crystal phase transition temperatures reported in the literature.

9717
CSO: 4009/59   - END -