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SCIENCE AND TECHNOLOGY

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CHINA REPORT

SCIENCE AND TECHNOLOGY

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NATIONAL DEVELOPMENTS

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Tianjin KEXUEXUE YU KEXUE JISHU GUANLI [SCIENTIOLOGY AND MANAGEMENT OF S&T] in Chinese No 6, 12 Jun 85 pp 2-4

[Article by Wang Yingluo [3076 2019 3157] of the Xian Communications University: "Some Strategic Questions in China's S&T Reforms"]

[Text] Science and technology [S&T[systems in China must undergo reforms corresponding to reforms of economic systems in our country. This is a strategic task that we now face on the S&T front.

A preliminary discussion of some strategic questions in China's S&T development based on social practice in S&T work in our nation over the past few years is presented below.

I. Scientific Research Organs and Scientific Research Management Systems

Scientific research organs in China originated in the 1950's. Scientific research management systems at that time were centered around the Academy of Sciences. State investments in scientific research and S&T forces focused on providing guarantees to the Academy of Sciences. Research institutes under the Academy of Sciences focused on basic theoretical studies. At the same time, research organs were established in all industrial departments. They engaged primarily in applied technical research, with each of the industrial departments providing administrative expenses and manpower. S&T forces overall were rather weak. A small number of research organs were established in institutions of higher learning only in the late 1950's and early 1960's. Expenditures on scientific research were rather small, however. Practice over the past 35 years has proven that many problems persist despite the rapid progress and major achievements that have been made in S&T work. The most prominent of them is that S&T work is detached from economic construction, leading to the phenomenon of "two skins." S&T development plans are not linked up with and do not match economic development plans. There is an inappropriate ratio between basic theoretical research, applied technical research and technical development in China. Utilization of limited state resources, capital and S&T forces is not sufficiently rational and there are mismatches. State administrative expenditures on scientific research mainly go to the Academy of Sciences system and are used mainly for basic theoretical research. In combination with the failure of upper levels of leadership to pay attention

to popularization and application of S&T achievements for a long time, transfers of technology among departments in China have proceeded slowly. Large numbers of S&T achievements remain in the laboratory. Few of them have been extended and applied in economic construction. One area here is that organizational organs are incomplete and that the links in applied technical research are extremely weak. Another aspect is the failure to consider the value of S&T achievements. The concept of compensated transfer of S&T achievements still has not been accepted by society as a whole.

It would be to our advantage to study the establishment of research organs and S&T management systems in Europe and America. Most major scientific research organs in the U.S., England, Germany, and other nations were set up in institutions of higher learning. Even some national defense and penetrating technology laboratories in the U.S. have been established at MIT, Stanford University and other famous institutions of higher learning. The Academy of Sciences is rather small in contrast. Moreover, some corporations have set up enormous research organs. The IBM Corporation, General Electric Corporation, ATT and others have very high-level research institutes or laboratories.

Why were all the major, high-level research organs in these countries set up through large investments in institutions of higher learning? First of all, well-known universities have outstanding talented S&T personnel and older professors with rich experience and high levels and there are academic echelons united around them. This new force in research staffs includes large numbers of dynamic graduate and undergraduate students. Such staffs make continuous innovations and provide new blood from beginning to end. Sparks of intellect often appear. Many discoveries and innovations, therefore, have been made here. Institutions of higher learning in Europe and America are not just centers of education. They also are scientific research base areas that continually produce talented people and achievements year after year. The fact that most professors usually are at the forefront of science means that they absorb fresh wisdom from vigorous discussions with the many young students during the educational process, which gradually deepens their understanding of things and laws. This develops their scientific knowledge and raise scholarly levels. The schools have thousands of undergraduate and graduate students. They are nourished continually in the sea of scientific knowledge and they vigorously and frequently emit sparks of wisdom. They dare to forge ahead and be creative. They are a research force under leadership by professors that cannot be ignored. Few scientific research organs can compare with them. From another perspective, only institutions of higher learning have the modern laboratories and advanced research offices that are essential for improving the talents of professors through scientific practice and continual improvements in their scholarly levels. Only then can the content of education be enriched and its quality improved. Moreover, this is essential for assuring that young students live in a concentrated scholarly atmosphere and strive to absorb scientific knowledge, improve their working abilities and train their ability to analyze and solve problems. For this reason, a dialectical unity has been achieved between production of talented people and achievements in institutions of higher learning. In contrast, if schools are merely sites for the transmission of knowledge and if education and scientific research

are antithetica, then no achievements will be possible and no capable people can be trained.

Moreover, institutions of higher learning are scholarly gardens where many disciplines are concentrated. This benefits mutual permeation and intersection between disciplines. The result has been that most marginal sciences appeared first in universities. Moreover, many very complex and comprehensive scientific research tasks were completed by cooperation between universities and certain scientific research organs in society. Furthermore, investments to build research institutes and laboratories in institutions of higher learning generally conserves on investments, provides rapid results and has obvious economic results. All universities are linked through the thousands of graduates who work in industrial enterprises. This is a technical extension network that formed naturally in society.

We feel that reforms in S&T management systems should change the traditional outdated viewpoint that ignores the important S&T aspects of institutions of higher learning. At the same time, we should pay full attention to research on applied technology and extend and apply S&T achievements into important positions. A respect for knowledge and for talented people should be treated as an important strategic task. To achieve this, we must acknowledge the strategic position of institutions of higher learning in China's S&T systems, especially the position of scientific and engineering institutions. China now has more than 800 institutions of higher learning, including nearly 100 key institutions of higher learning, but only a few 10 million yuan in S&T expenditures are allocated by the state each year. This is only a very small part of national S&T expenditures. The state will provide several billion yuan in administrative expenditures for attacks on key S&T problems during the Sixth 5-Year Plan, but very little will go to institutions of higher learning. This situation already has had a major influence on the cause of science and technology and on economic development in China, and it has had inestimable effects on the quality of personnel.

II. The Developmental Path of Technology in China

Technical progress is an organic component of socioeconomic development as a whole. If it is detached from the original foundation and current situation in a country and if advanced technology develops without regard for socioeconomic conditions, many negative consequences inevitably will arise.

Many advanced industrial nations have striven for nearly 100 years to attain the scientific and technical achievements they have today, and they are developing rapidly on the basis of their existing achievements. A new technological revolution now is taking shape. Some developing nations are in urgent pursuit in an attempt to catch up with the advanced nations. Practice over the past several decades has proven, however, that their efforts do not attain the predicted results, sometimes to the extent that a tendency for the gap to widen has appeared. The main reason is that many developing nations independently have emphasized the development of

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advanced S&T while failing to consider the environmental conditions that are closely related to the development of advanced technology. They are concerned only with technology imports and have not studied importation, digestion, absorption and redevelopment in their entirety. The result is a continual increase in advanced technical projects that require very expensive investments. Often, they cannot function to their fullest because of a poor ability to digest and absorb, leading to poor economic results. Iran, for example, relied on its enormous wealth to import a large amount of advanced technology from China, but it has not attained social and economic modernization. Instead, there has been a dynastic restoration. Brazil borrowed enormous sums from U.S. banks to build the world's largest dam, but it can store no water and is on the verge of bankruptcy. China imported a large number of equipment sets in the late 1970's, but our failure to pay attention to digestion and absorption made it impossible to attain full results and sometimes led to enormous economic losses. This historical experience has appeared in most of the developing nations of the world, and it has caused people to study the question of management and application of advanced technology in earnest.

The ability to manage and apply does not refer only to sources of capital and foreign exchange. Many developing nations have focused their efforts on collection of capital, but they have depended on loans, joint investment and management, compensated trade and other forms to get the capital, and they have been unable to guarantee smooth development of advanced technology. Advanced technology in developed nations was formed gradually under economic conditions of high productivity and cheap resource supplies and on the foundation of cultural traditions and technology. An "indiscriminate strategy" is unfeasible. It is easy to consider natural conditions but the influences of the social and economic environment are even more profound and are not easily perceived. The ability to manage and apply advanced technology usually has two aspects. The first is the ability to readjust advanced technologies to conform to the social and economic environment in one's own country. The second is to readjust the social and economic environment in accordance with development of new technologies.

The ability to accept advanced technologies can be divided into three levels. The most basic level is the ability to use them. This demands a grasp of utilization, maintenance and readjustment methods of a technology. Even more important is an understanding of the secrets of key technologies and managerial methods. The second level is the ability to design, which involves digestion of advanced technologies followed by dynamic utilization and the ability to design new equipment and techniques. The third level is the ability to develop, which involves continual enrichment, innovation and development of new products on the basis of digestion and absorption. Japan's post-war iron and steel industry, for example, imported ironmaking blast furnaces from the U.S. and Germany, steelmaking converters from Austria and steel rolling equipment from the U.S. Continuous casting technologies came from Switzerland, West Germany, the Soviet Union and other countries. Japan integrated with its special conditions, including a small territory, frequent earthquakes, loose soil quality, the use of seawater as a cooling agent and other conditions and used this equipment

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very well. This was the first level. At the same time, they digested and absorbed these different technologies to design purely Japanese iron and steel producing enterprises, which was the second level. On this foundation, they next computerized the steelmaking process, which raised the level of continuity in steelmaking to a level higher than any other nation, and they are exporting complete sets of equipment. This shows that Japan now has the ability to develop.

The ability to readjust social and economic structures refers first of all to basic structures like communications, transportation, water and electricity supplies, information centers and so on. It also includes educational levels, research forces, the ability to evaluate technology and so on. Secondly, it refers to organizational structures, management systems and the like, which means technological progress and economically feasible technologies. Without the appropriate decision-making rights in management systems, there will be no dynamism or motivation and pressure to compete. It still will be possible that they will not be put into practice or that they will not achieve excellent economic results.

Furthermore, the understanding, interest and need for technology of people at different layers of structure in society influence the development of new technologies to a substantial degree. The scientific and cultural levels of a people and the need of the broad masses for new technologies is a fundamental force in technological development. S&T personnel are the central force in promoting development of technology. Their initiative and motivation plays a key role. The uppermost level is leaders and policymakers. They play a strategic role in social and technological progress, and their sense of innovation and spirit of development have profound influences on socialist modernization and construction.

III. Open Up Technology Markets, Give Consideration to the Value of Information

Science and technology are forces of production, but there must be certain conditions before they can be converted into forces of production. The true value of a technical invention is unknown before rights over it are transferred. Its value can be known only after rights are transferred and it is used in production. Under socialism, technology also is a commodity. Commercialization of a technical product and compensated transfer of a technology lead to the circulation of technologies and also can invigorate the economy and lead to circulation of intellect and personnel. This means that market regulation of technological commodities truly motivates the initiative of S&T personnel to invent and innovate and thereby can benefit in training developmental personnel with a sense of innovation and spirit of development.

Reforms in S&T systems take many shapes. First of all, the detachment of S&T from economic development and the inability to convert technical achievements into forces of production must be corrected and the rate of technological conversion must be accelerated. Low efficiency and poor results can be overcome only to speeding up circulation of technological

commodities to increase the motivation and pressure to develop technology. At the same time, technical consultation, technical services and technical trade organically integrate science, industry and trade, which invigorates technical work. It also invigorates the economy and breaks through the restrictions between regions and sectors. Only then is it possible to break through the system of departmental ownership of personnel. Improved treatment of technical personnel will be more conducive to promoting initiative and creativity to develop new technologies and make further use of knowledge, causing intellectuals to more consciously serve economic construction. Only then will it be possible to implement fully the S&T policy of the party that "the economy must rely of science and technology, while science and technology must be oriented toward economic construction."

During the era of the modern commodity economy, not only has technology become a commodity, but technical services and information also have become commodities. Technology and information both play an important role as catalysts in development of the commodity economy. For a long time, we adopted a policy of sealing off the country to the outside. This cut China off from information and closed our eyes and ears to informational society. It seriously obstructed the development of society, the economy, science and technology in China to the extent that even today people do not fully appreciate the value of information and have not made full use of the benefits of information. The resolution of the 3d Plenum of the 12th CPC Central Committee concerning reforms in economic systems pointed out a clear policy of opening up to the outside and invigorating the economy within China. This is entirely correct and suited to the socioeconomic development needs of China at the present time. In correspondence with this, we must strive to open up technology markets and strengthen technical services and information gathering, processing and transmission to actively develop technical and economic advisory services work.

In summary, the strategic tasks facing socialist modernization and construction in China by the end of the century and the crashing waves of the world's new technological revolution require us to link up with the overall situation, be farsighted and carry out intensive strategic research and policy analysis based on the characteristics of modern science and technology, on developmental trends and the laws of technical progress, and on China's national conditions and cultural traditions and history and current situation in social and economic development to explore a comprehensive strategy for reforms of technical systems and S&T development in China.

12539
CSO: 4008/391

NATIONAL DEVELOPMENTS

ZHANG DENGYI STRESSES S&T COMMERCIAL APPLICATION

Stockholm SVENSKA DAGBLADET in Swedish 21 Jul 85 p 11

[Article by Dag Bjerke: "China's Scientists Must Think Commercially"]

[Text] China has opted for the commercial route with regard to science. Govern-
ment grants will be cut back and research institutes will become independent.
Research will be forced to cater to the needs of industry.

"Science will serve the economy," says Zhang Dengyi, head of China's Science
and Technology Commission, which is responsible for administering the govern-
ment's support and control of scientists.

Eleven years ago, during the Cultural Revolution, he would have said--or been
forced to say--that science should serve the people.

"Well, the economy does exist for the sake of the people," he now explains.

Notwithstanding this explanation, our continued conversation made it quite
clear that China has now, after several indecisive years following the deaths
of Zhou Eulai and Mao Zedong and the fall of the "gang of four" in 1976, opted
for a pragmatic and commercial approach.

Self-Supporting Institutions

"We intend to cut back government grants to various research institutes--with
the intention that they will become self-supporting. They will exert themselves
to work on projects which can be put on the market, and the proceeds will go
to the institute and not to the state, as was previously the case."

"They will be forced to engage in research which is related to the real needs
of industry, and to avoid projects which represent the unrealistic dreams of
the people and their representatives."

Zhang Dengyi cites an example of such a project, dating from the time of the
Cultural Revolution:

"During the '60s the government ordered that research be directed towards the development of a fully automated, unmanned train locomotive--a totally unrealistic, ridiculous and extreme project."

Open to Bidding

"In many cases we will continue to allow various institutions to bid on research and development projects desired by the government, and economic evaluation of the bids received will figure heavily in our recommendations to the government."

Zhang Dengyi's organization, abbreviated SSTC [State Science and Technology Commission] has set up a priority list comprising a total of 38 different areas of research which will be stressed during the 5-Year Plan which begins in 1986.

Agricultural research, such as research into the production of new, high-productivity and economically viable types of wheat, corn and cotton, is at the top of the list.

Energy research is in second place, and the stress will be laid on conventional energy sources such as hydroelectric power, coal and oil furnaces.

With help from France and West Germany, China is about to build its first nuclear power plant, and the second plant is already on the drawing board.

They are apparently stepping into the age of nuclear power very carefully, and enthusiasm for this type of power source seems to have diminished considerably since the author last visited China in 1974.

Zhao Chuanshao, head of the State Bureau of Electrical Power and Water Resources, states today:

"Having taken note of other countries' experiences with regard to the safety problems and environmental impact of nuclear energy, we will stress the development of pollution-free and renewable hydroelectric power."

"At present hydroelectric power accounts for 25 percent of our country's total electrical power output, a figure which we count on increasing to 33 percent by the year 2000, while we reckon that nuclear power will account for only 4 percent of the total," says Zhao Chuanshao.

Preliminary plans include a total of 10 Chinese nuclear power plants in the foreseeable future.

"In this context, we must remember that China has great coal reserves."

Back to the top of the SSTC's list of 38 priorities:

Communication is listed in third place, with special emphasis on the development of heavy transport vehicles and new electric locomotives.

The fact that China has been able to achieve an evenly-distributed state of economic well-being (= absence of want) since 1949 despite an extremely poor transportation system is due to a large extent to China's highly decentralized, small-scale industrialization, which is based on "people's communes" in rural towns.

The new economic course will entail the need for centralization and large factories--thereby also entailing a great demand for a functional transportation apparatus.

Faster Food

Farther down on the SSTC's list we find more consumer-oriented research and development:

"It is becoming more and more common for both parents in the family to work, and time-consuming Chinese meal-preparing procedures must be reformed," says Zhang Dengyi:

"There is no fast food today in China, and we intend to initiate the production of, for example instant noodles, and to improve the quality of our bread."

"Furthermore, we will produce more household appliances to help in the home."

This increased emphasis on applied and economically-profitable research will not preclude basic research, necessary medical research or some pure research, according to Zhang Dengyi.

"The medical research institutes will still receive a specified annual grant, which must survive on," says Zhang Dengyi.

As an example of the type of adventurous pure research in which China will continue to be involved he cites the fact that China is considering getting involved in the large-scale production of LSI electronics, i.e., large integrated circuits on tiny silicon chips.

"Not that we seriously hope to compete with the United States or Japan in this field."

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CSO: 3650/310

SHANGHAI TRANSFERS TECHNOLOGY, MANAGEMENT INLAND

OW060756 Beijing XINHUA in English 0745 GMT 6 Jul 85

[Text] Shanghai, 6 Aug (XINHUA)--Colorfully-clad girls of Jingpo nationality in southwest China performed a folk dance to thank the textile workers from Shanghai who helped them to manufacture their first jacquard cloth.

With technical assistance by Shanghai workers, the minority nationality of Junnan Province no longer has to weave the cloth by hand, local officials said.

Shanghai has accelerated its cooperation with other places in recent years. The city and other regions jointly set up 1,000 economic and technical items of cooperation in 1984, double the total for the previous three years. It has also signed agreements covering 500 technical cooperation projects with Yunnan, Ningxia, Xinjiang and Tibet, areas mainly inhabited by minority nationalities.

Among the effective cooperation are the following:

--three bicycle factories in Suzhou, Shaoxing and Nantong cities plan to turn out 1.2 million famous-brand bicycles in cooperation with two Shanghai factories this year;

--twelve textile mills in Shandong Province have upgraded their products, increased designs and improved economic results. Cloth from some mills has already found international market; and

--more research findings have been applied to production. At a technical fair, 190 scientific achievements changed hands. A valve factory in Jiangsu Province has increased its finished products by 30 percent and added five new varieties with technology provided by the Jiaotong University.

Shanghai authorities state that local colleges have set up more than 100 research-production cooperation projects with other regions. The 500 technological consultancy units have undertaken more than 10,000 projects involving production techniques, management, information service, funding and trade for enterprises outside Shanghai.

Through cooperation, the inland provinces provide Shanghai with energy, pig iron, non-ferrous metals, building materials and primary products that are often in short supply in return for supplies, techniques and funds from Shanghai.

Shanghai is also importing more advanced techniques. The city signed agreements with foreign firms on 270 import schemes involving 900 million U.S. dollars last year, four times the amount in 1983, local officials said.

CSO: 4010/2012

NATIONAL DEVELOPMENTS

SHENZHEN BUILDING SCIENCE, TECHNOLOGY CENTER

OW312033 Beijing XINHUA in English 1625 GMT 31 Jul 85

[Text] Shenzhen, July 31 (XINHUA)--A foundation stone was laid on Tuesday
for a scientific and technologocal research center in the Shenzhou Special
Economic Zone, Guangdong province.

The center, which will eventually cover 3.2 sq km, will be a place of
scientific research and education focusing on microelectronics, optics,
precision machinery and new materials.

Jointly sponsored by Shenzhen City and the Chinese Academy of Sciences, a
corporation was set up yesterday to supervise the construction, which will
include facilities for sino-foreign joint ventures.

Zhang Yiyi, general manager of the corporation, said preferential treatment
will be granted to imported advanced technology which yields major economic
benefits, according to the interim regulations of the economic zone.

The center is also an attempt to integrate the work of the Chinese Academy
of Sciences with production, said Zhou Guangzhao, the academy's vice-president.
He pledged that the more than 40,000 scientists and technicians of the
academy would endeavor to build the special economic zone into an export-
oriented and technology-intensive one.

Fang Yi, member of the Political Bureau of the Communist Party of China,
wrote an inscription for the center, and state councillor Gu Mu sent a
letter of congratulations on the occasion.

CSO: 4020/315

NATIONAL DEVELOPMENTS

ACADEMY OF SCIENCES TO OPEN RESEARCH TO FOREIGNERS

OW230930 Beijing XINHUA in English 0847 GMT 23 Jul 85

[Text] Beijing, 23 Jul (XINHUA)--The Chinese Academy of Sciences has decided to open 17 laboratories and two research institutes to foreign scientists who wish to do research there, academy sources said her today.

They include the Beijing-based Theoretical Physics Institute and the Institute of Mathematics, the Structural Chemistry Laboratory of the Fujian Institute of Research on the Structure of Matter, the Vacuum Physics Laboratory in Beijing, the Engineering Geomechanics Laboratory of the Institute of Mechanics in Beijing, the Ion and Infrared Physics Laboratories in Shanghai and the Laser Spectrum Laboratory of the Anhui Institute of Optics and Fine Mechanics.

This is part of efforts undertaken by the academy to help the country's current reform of the scientific and technological research management system, aiming at doing away with the former practice of closed door research and promoting exchange and cooperation between the academy's scientists and those in other departments, as well as abroad.

The academy has worked out the regulations on management of the laboratories and invited noted scientists to act as directors of the laboratories and academic committees. Both Chinese and foreign scientists can apply for research projects to the academic committees. With the committees' approval, they can do research work at the laboratories and receive financial support.

As China's comprehensive research center for natural sciences and technology, the Chinese Academy of Sciences has more than 100 related research institutes across the country, mainly for basic research.

CSO: 4010/2012

SINO-AUSTRALIAN TECHNICAL COOPERATION MEETING ENDS

OW250554 Beijing XINHUA in English 0250 GMT 25 Jul 85

[Text] Canberra, 24 Jul (XINHUA)--The 1985 Sino-Australian consultation meeting on technical cooperation came to a successful end today, resulting in a record of proceedings about the cooperation between the Chinese Government and the Australian Government after three days of sincere and friendly discussions among the economic officials of the two countries.

The record of proceedings was signed late this evening (2300 hours local time) here by Li Ke, deputy to the Chinese minister of foreign economic relations and trade, and Dr Robert J. Dun, acting director-general of the Australian Development Assistance Bureau (ADAB), on behalf of their respective governments.

At the signing ceremony, the two sides also signed memorandums of understanding relating to the "dental materials research project" and (China's) "Gansu agricultural systems research center project."

The Sino-Australian technical cooperation programme for development commenced in 1981 and an agreement confirming the relationship was signed by the two countries in October the same year. The principal objective of the programme is to assist China in her development programme through the demonstration of Australian technology.

With a view to making this meeting a success, Australia sent a delegation to China last April to hold preliminary talks with their Chinese counterparts.

The Chinese delegation headed by Li Ke arrived in Sydney on 18 July.

CSO: 4010/2012

NATIONAL DEVELOPMENTS

ACADEMY OF SCIENCES TO BACK YOUNG SCIENTISTS

OW260804 Beijing XINHUA in English 0646 GMT 26 Jul 85

[Text] Beijing, 26 Jul (XINHUA)--The Chinese Academy of Sciences has al-
located 2.5 million yuan as a fund to encourage young scientists under the
age of 35 to display their talents.

President of the academy Lu Jiaxi said at the academy's working conference
early this year, the academy would allocate 10 million yuan as the special
fund at the president's disposal, to reward those who make contributions
in major research projects and support young scientific workers in their
research.

The setting up of the fund, as part of efforts undertaken by the academy
to help the country's current reform of scientific technological research
management, aims at encouraging scientists to dedicate themselves to the
modernization program.

Academy sources said that part of the fund would be used to support those
studying for doctorates while doing research work at present.

CSO: 4010/2012

NATIONAL DEVELOPMENTS

GUANGMING RIBAO ON RESEARCH-PRODUCTION GROUPS

OW091040 Beijing XINHUA in English 1030 GMT 9 Aug 85

[Text] Beijing, 9 Aug (XINHUA)--According to the Beijing Science and Technology Committee, more than 150 research-production cooperatives--joint ventures between research institutes and enterprises--have been set up, today's GUANGMING DAILY reported.

The Beijing Science and Technology Coordination Center promotes cooperation among 67 research and design institutes, 12 universities and 20 industrial bureaus in Beijing. Each year, they sign several hundred contracts.

The research institutes also cooperate with other cities and provinces. The Beijing Technology and Sciences Committee and Qinhuangdao in Hebei Province have sponsored a company which deals with the transfer and exchange of research findings. It is directed by a council consisting of the representatives from both sides.

Another kind of cooperation is research institutes providing the technology as their investment, while the enterprises provide labor, equipment, workshops and most of the capital. The enterprises are controlled jointly and the profit shared.

Some research institutes contract certain technological projects for enterprises, which cover the whole expense for the research. The benefitted enterprises pay technological service fees.

This kind of research-production cooperation allows more research findings to find practical application. The 80 research institutes in Beijing contracted some 1,200 technological items for enterprises in 1984, 61 percent more than in 1983. And they transferred nearly 400 research findings to industry, a 162 percent increase.

The paper commented, "these kinds of cooperatives meet the needs of the reform of science and technology management, and the entire economic system."

CSO: 4010/2012

NATIONAL DEVELOPMENTS

SHANDONG MEASURES ON REFORMING SCIENTIFIC SYSTEMS

SK220123 Jinan Shandong Provincial Service in Mandarin 2300 GMT 20 Aug 85

[Excerpts] The provincial scientific and technological work conference spon-
sored by the provincial CPC Committee and the provincial People's Government
opened in Jinan City on 20 August. The conference is chiefly aimed at further
studying and implementing the decision made by the CPC Central Committee with
regard to conducting reforms in scientific and technological systems and the
important speeches given by the central leading comrades at the national
scientific and technological conference, holding discussions on revising the
draft plans formulated by the provincial CPC Committee and the provincial
People's Government with regard to conducting systems in scientific and
technological systems, and at studying the province's concrete measures for
conducting reforms in scientific and technological systems.

Ma Changgui, vice governor of the province, presided over the conference at
which Lu Amozeng, deputy secretary of the provincial CPC Committee, delivered
an important speech in which he pointed out: In studying or mastering the es-
sence of the spirit of the central decision on conducting reforms in scientific
and technological systems, it is most important for us to further define the
fundamental purpose and guiding ideology of the decision. This is the impor-
tant premise of having the program of conducting reforms in scientific and
technological systems achieve smooth progress along the correct direction.

In his speech, Comrade Lu Maozeng stressed: In studying or mastering the es-
sence of the spirit of the central decision on conducting reforms in scientific
and technical systems, we should also ideologically define the following four
questions:

1. In conducting reforms in scientific and technological systems, it is im-
perative to reform the existing system of appropriating funds for scientific
research.

2. In conducting reforms in scientific and technological systems, it is im-
perative to meet the need of developing the socialist commodity economy and
to open technological markets in order to commercialize scientific and tech-
nological results.

3. In conducting reforms in scientific and technological systems, it is im-
perative to strengthen enterprises' ability in absorbing advanced technology
and developing new technology.

4. In conducting reforms in scientific and technological systems, it is imperative to reform the managerial affairs over scientific and technological personnel in order to fully create a good circumstance in which talented people can come forth in large numbers and people can use their ability to the fullest.

In conclusion, Comrade Lu Maozeng stated: In the course of conducting reforms, we should implement the principle of being steadfast, being prudent in fighting in first battle, and being sure to win.

Efforts should be made to uphold the ideological line of seeking truth from facts, to proceed every work from the reality, to dare to engage in practice and make progress, to earnestly implement the strategic principle of having the program of economic construction depend on science and technology and gearing the scientific and technological work to the program of economic construction, and to strive to make scientific and technological undertakings and the province's economy flourishing.

CSO: 4008/2025

NATIONAL DEVELOPMENTS

SHANDONG GOVERNOR'S SPEECH AT SCIENCE CONFERENCE

SK241205 Jinan Shandong Provincial Service in Mandarin 2300 GMT 22 Aug 85

[Text] On the morning of 22 Augut, Li Changan, deputy secretary of the pro-
vincial CPC Committee and governor, delivered a speech at the provincial
scientific and technological work conference. He said: In implementing the
central decision on reforming the structures of science and technology, our
current task is to .continuously deepen our understanding of the decision in
the cause of implementation, conscientiously organize people to implement it,
and realistically fulfill the demands defined in the decision.

In line with our province's actual situation, Comrade Li Changan touched on
issues involving four aspects: 1) The reform of the structure of science and
technology is a task of strategic significance. 2) In reforming the structure
of science and technology, we should adhere to the orientation of serving the
economic construction. 3) The key link of the scientific and technological
structural reform is to invigorate the scientific research units. 4) The
most important thing in such reform is to respect knowledge and talented per-
sons.

In his speech, Comrade Li Changan pointed out: We should approach scientific
and technological structural reform from the perspective of the overall reform
situation and the success and failure of the four modernizations. At present,
the province-wide economic structural reform is being deeply carried out.
Therefore, the reform of the scientific and technological structure must rapid-
ly keep pace with the economic structural reform. In the rural areas, the old
practice of the three-level system of ownership of the means of production in
the people's communes, with ownership by the production team as the basic form,
has disappeared and is being transformed from a self-supporting and half self-
supporting economy into a large-scale commodity economy. The spheres which
require science and technology are increasingly expanding. In the urban areas,
we have expanded the decision-making power of large enterprises, and invigor-
ated and relaxed control over medium-sized and small enterprises. The various
economic sectors and circulation channels have been greatly developed. This
has stimulated enterprises to increase economic results, to speed up the up-
dating and upgrading of products, and to raise their competitive capabilities.
The demands of technical progress have become more pressing. Only by breaking
with the outdated, confining and rigid system and realistically solving the
problems of serious dislocation between scientific research and production can
the scientific research departments better satisfy the needs, in terms of

science and technology, of all trades and professions. This shows that the scientific and technological structural reform must be carried out along with the economic structural reform and both should conform with each other. Otherwise, it would be impossible to consolidate the achievements in the economic structural reform and to rapidly develop scientific and technological undertakings.

In his speech, Comrade Li Changan stressed: Only by adhering to the strategic policy that economic construction must rely on science and technology and that the scientific and technological work must cater to the needs of economic construction, and by persisting in serving economic construction, can we have a correct orientation for the reform of the scientific and technological structures. In making science and technology serve economic construction, we should not only pay attention to immediate interests, but also to future interests. We should pay attention to the grand goal of realizing the four modernizations and should strive to catch up with and surpass the world advanced level. At present, one of the most important tasks of the scientific research units and scientific and technical workers is to help backward areas change outlook within a short period of time and to help all trades and professions tackle technical problems. We should first give consideration to the needs of backward areas in the course of building scientific research bases, popularizing scientific and technological achievements, and developing scientific research and production associations. From now on, we should organize strength in a unified manner, share the work and cooperate with one another, and concentrate our efforts on making breakthroughs in carrying out those key projects that may affect the overall situation, so that scientific research will out-pace economic construction. To this end, the broad masses of scientific and technological workers should emancipate their minds; exert efforts to tackle problems; narrow the gap in the area of scientific and technological research between our province and the developed countries; and keep pace with the world's new technological revolution.

In his speech, Comrade Li Changan emphatically pointed out: The key to establishing vigorous new scientific and technological structures lies in vitalizing scientific research units. He said: In accordance with the demands of the central decision, and in drawing on the experience of the economic structural reform, we realize that in order to vitalize scientific research units, we should proceed mainly from two aspects in work: 1) We should change the method of appropriation of funds and develop technological fairs. 2) We should reform the organizational structure of the scientific and technological departments and promote various forms of cooperation among scientific research units, higher educational institutes, and production enterprises.

In reforming the system of appropriating funds, we should first implement the policy of payment for the utilization of the three-purpose scientific and technological funds, and change appropriations into loans. Second, we should appropriate the scientific and technological operating funds according to different cases. Such funds will be reduced yearly according to the self-support level of the scientific research units, or utilized on a contract basis. Third, we should establish the two-level scientific and technological development funds--the provincial level and the city and prefectural level--mainly for developing major technical items, and should secure payment for the

utilization of such funds. Developing technological markets is a precondition
for reforming the system of appropriating funds. If we fail to implement the
policy of paying for the transfer of technological achievements, it will be
impossible for scientific research units to become self-supporting or basically
self-supporting in terms of their operating funds. What we are now imple-
menting is a planned commodity economy. In making scientific research units
serve production, we should acknowledge that technological achievements are
knowledge-type commodities. The greater the scope and the greater the number
of exchanges involving such achievements, the greater the development of the
commodity economy and the quicker the development of science and technology.
Another important task in invigorating scientific research units is to read-
just the structure of scientific and technological organizations, to establish
lateral ties, and to fully display the dynamic role of scientific research
units in serving production. The provincial scientific research and design-
ing units and institutions of higher learning should break with the barriers
between regions and departments and establish various forms of technical
cooperation with enterprises as well as with all trades and professions in ac-
cordance with the principle of voluntariness and mutual benefit, in an effort
to form a long-term and stable technical cooperative relationship, and to
strengthen the capabilities of enterprises in absorbing technology and in de-
velopment.

In his speech, Comrade Li Changan emphatically pointed out: Knowledge and
talented persons are a key to invigorating our various undertakings. In re-
forming the structure of science and technology, we should trust and rely on
the broad masses of intellectuals on the scientific and technological front
and the reform should be conducive to further liberating the intellectuals so
that their knowledge and talents can be fully displayed. He said: As far as
the development of an enterprise is concerned, first, it should respect know-
ledge and talented persons; second, it should apply the advanced technology
and techniques to production; third, it should provide quality products and
services for consumers; and fourth, it should be brave in facing the top level
of the country and the international markets. Of these, the most important is
to respect knowledge and talented persons, because no matter what we intend to
do, such as adopting new technology and techniques, raising the quality of
products, and facing the domestic and international markets, we cannot deviate
from a group of talented persons of various descriptions who have pioneering
spirit, including plant directors, engineers, and technicians, as well as from
the creative labor of the broad masses of staff and workers. We should further
understand the importance of talented persons, and further advance our under-
standing in this regard, and should create a good environment for fostering
more talented persons and making full use of their talents in the course of re-
forming the structure of science and technology.

Comrade Li Changan said: Reforming the structure of science and technology is
a major matter involving the entire party and society. The CPC Committees
and governments should exert the same efforts to strengthen leadership over
such reform as they did in the economic structural reform, give careful guid-
ance, and organize the implementation of the central decision well. Leaders
at all levels should realistically improve their workstyle, speak fewer empty
words and carry out more practical work, and study and resolve new situations

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and problems emerging in the course of reform, in order to ensure the smooth progress in the reform of the scientific and technological structure.

At the conference held on 22 August, Guo Shuyan, vice minister of the State Science and Technology Commission, delivered a report on reforming the structure of science and technology. He profoundly expounded on the necessity and urgency of such reform; the principle and guidelines of the reform; and a series of important issues in reforming the system of appropriating funds, developing technological markets, strengthening the capabilities of enterprises in absorbing technology and in development, respecting knowledge and talented persons and giving full play to the role of intellectuals. In his report, Guo Shuyan pointed out: The central decision on reforming the structure of science and technology is another important strategic policy decision following the decision on the reform of the economic structure. Implementing such a policy decision and making the scientific and technological structural reform successful is of great significance in making China prosperous and realizing the grand objective of quadrupling the total industrial and agricultural output value by the end of this century.

CSO: 4008/2025

NATIONAL DEVELOPMENTS

HUBEI SETS UP ANALYSIS, MEASUREMENT CENTER

OW231435 Beijing XINHUA Domestic Service in Chinese 0117 GMT 22 Aug 85

[Excerpts] Beijing, 22 Aug (XINHUA)--XINHUA editor's note: The experience
of the Hubei Provincial Scientific and Technological Commission indicates
that there is a great potential in manpower, financial, and material re-
sources in many localities throughout China. At the same time, it also
shows that when we do something new, there is no need for us to open up a
new "temple" and provide it with a new "god." Actually, if one ventures
out of one's small area or departments, takes into consideration the entire
situation as a whole, reforms the management system, and changes the organ-
izational structure, and can achieve the goal of killing many birds with one
stone by spending only little money or nothing at all, we hope that this ex-
perience will draw the attention of those provinces, cities, and trades that
have asked for state funds to set up analysis and measurement centers.
[end of editor's note]

Report by reporter Qin Fengtong: The Hubei Provincial Scientific and Tech-
nological Commission has blazed a new trail in China by setting up a provin-
cial level analysis and measurement center. It has tapped potential in
society by forming a "combined" force, and achieved its goal by spending
little or nothing at all. On instruments alone, it has saved the state
some 30 million yuan. This experience has recently aroused the great inter-
ests of those comrades who attended the national meeting on scientific and
technological conditions held in Yinchuan. It has been commended by the
State Scientific and Technological Commission.

Analysis and measurement centers are like scouts and telescopes that help in
conducting scientific research and developing economic construction. Speak-
ing on the Sixth 5-Year Plan, Premier Zhao Ziyang said: "It is necessary to
set up, in a planned way and step by step, public analysis and measurement
centers in the provinces, municipalities, and autonomous regions to serve
scientific research and national economic growth."

The joint analysis and measurement center in Hubei Province was officially
established in October last year. Those who worked at the center came from
Wuhan University, the Wuhan Geological College, the Wuhan Chemical Research
Institute, the Provincial Bureau of Meteorology, the Provincial Bureau of
Geology and Mining, the Academy of Agricultural Science, Hubei Province,
and the Hubei Medical College and other units. The principal responsible

persons of these units formed a central leading committee. The departments for scientific and technological conditions under the Provincial Scientific and Technological Commission was responsible for handling the routine work of this leading committee. Right now, over 700 scientists and technicians of all types are working for the joint center, which has over 100 large high-precision instruments of all types with a total value of more than 30 million yuan.

In less than 6 months, this center has signed agreements with more than 100 units to tackle various difficult technical problems. It has also solved many difficult problems in production for various enterprises, and played a signi-icant role in developing new products and new technologies and in investigating and utilizing natural resources in the province.

CSO: 4008/2025

NATIONAL DEVELOPMENTS

GUIZHOU HOLDS SCIENTIFIC, TECHNOLOGICAL CONGRESS

HK270610 Guiyang Guizhou Provincial Service in Mandarin 2300 GMT 25 Jul 85

[Recorded report: "The Third Congress of the Provincial Scientific and Technological Association Solemnly Opens"]

[Excerpts] The Third Congress of Guizhou's Scientific and Technological Association solemnly opened at the provincial people's government hall yesterday afternoon.

[Begin recording] [Unidentified speaker] Dear Comrades, I now declare the opening of the Third Congress of Guizhou Province's Scientific and Technological Association. [end recording]

Xu Caidong, vice governor and deputy director of the provincial scientific and technological association, presided over the opening ceremony. The young pioneers of Guiyang City (Shifulu) primary school played music and, with flowers in their [word indistinct], congratulated the congress. Over 600 representatives from the province's scientific and technological associations, as well as their subsidary academic organizations, attended the ceremony. Also present were the leading comrades of the province's party, government and military, including Wang Chaowen, Ding Tingmo, Su Gang, He Rendong, Zhang Yuhuan, [name indistinct], (Tang Hongren), (Zhu Yiru), (Yan Jiaqi), [name indistinct] and (Zhang Zhezhong).

Bao Yishan, secretary of the leading party group of China Association for Science and Technology, as well as scientific and technological representatives from fraternal provinces and cities, including Yunnan, Sichuan and Jiangsu, also attended the session on invitation.

Luo Dengyi, director of the provincial scientific and technological association, delivered the opening speech.

Representatives of the provincial federation of trade unions, the provincial CYL, the provincial women's federation, the provincial federation of literary and art circles, the provincial federation of workers of social sciences, and other mass organizations congratulated the congress.

The congress has received congratulatory letters, telegrams and presents from scientific and technological associations in such fraternal provinces, cities

and regions as Yunnan, Sichuan, Zhejiang, Guangxi, Xizang, Shanghai, Jiangxi, Chongqing, Fujian, Hunan, Jiangsu, Guangdong, Anhui and Ningxia.

On behalf of the scientific and technological associations in the fraternal provinces and cities, (Zhang Li), deputy director of Jiangsu Province's Scientific and Technological Association, delivered a congratulatory speech. (Dao Yushan), secretary of the CPC Committee of China Association for Science and Technology, expressed congratulations on behalf of the China Association for Science and Technology on the convention of the congress.

[Begin recording] Dear representatives and guests, the Third Congress of Guizhou's Scientific and Technological Association solemnly opens today. This is a grand meeting of the scientific and technological circles. The China Association for Science and Technology offers congratulations on the opening of the congress.

I extend warm greetings and respect to the workers of Guizhou's scientific and technological circles. [end recording]

In his speech, he fully affirmed the achievements made by the provincial scientific and technological association over the past five years. He expounded on the role of scientific and technological organizations in promoting China's scientific and technological undertaking, and in achieving the party's lfoty goal by the turn of the century. He hoped that the provincial scientific and technological association would further make clear the direction and task, fully mobilize the initiative of scientific and technological workers and make more and greater contributions toward invigorating Guizhou's economy.

Ding Tingmo, deputy secretary of the provincial CPC Committee, spoke at the congress. In his speech, Comrade Ding Tingmo hoped that the province's scientific and technological organizations and workers will keep abreast of the new situation, uphold reforms, [words indistinct], bear to the needs of the economy, do more practical work, improve the quality, strengthen party spirit, and integrate their destiny, career and ideals with the development of the province. He also hoped that they will use their wisdom to benefit the masses, make progress despite difficulties, and make new contributions for Guizhou's people and toward invigorating Guizhou.

At the session held yesterday, (Li Liangqi), deputy director of the provincial scientific and technological association, delivered a work report on behalf of the second committee of the provincial scientific and technological association. The title of the report was "The Province's Scientific and Technological Workers Unite To Make Contributions Toward Invigorating Guizhou."

NATIONAL DEVELOPMENTS

NEI MONGGOL OFFICIAL'S REPORT ON SCIENCE-TECHNOLOGY REFORM

SK310946 Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 27 Jul 85

[Text] At the regional work conference on science, technology, and educa-
tion, Xu Lingren, Standing Committee member of the regional CPC Committee and
director of the regional Scientific and Technologic Commission, delivered a
report in which he pointed out: The current prominent question faced by
the scientific and technological workers is to integrate scientific and
technological work with economic work. By conducting reforms in the scien-
tific and technological systems, we should enable scientific research work
to be turned into a motive force and to actively merge itself into production.

Xu Lingren stated: In line with the decision made by the CPC Central Commit-
tee with regard to conducting reforms in the scientific and technological
systems and the region's actual situation, we must unswervingly do a good
job in grasping the following seven tasks in a down-to-earth manner:

1. Do a good job in conducting reforms in the system of appropriating funds
for scientific and technological work, which is the key to conducting reform
in the scientific and technological systems. In reforming the system of ap-
propriating funds for scientific and technological work, it is imperative to
uphold the characteristics of scientific and technological activities in var-
ious fields and to conduct classified management. The scientific research
units in charge of urban technical development should have their funds appro-
priated by the state gradually reduced in order to enable them to increase
their incomes by selling their technical results and rendering technical ser-
vices. From now on we will strive to enable them to achieve self-sufficiency
in funds in the coming 5 years. We will enforce the responsibility system
for research funds among the agricultural scientific research units and re-
search units in charge of social welfare, scientific services, and technical
foundation. Meanwhile, efforts should be made to encourage the units that
have conditions to create income by means of their strong points and to
achieve self-sufficiency in research funds step by step.

2. A good job should be done in opening more technical markets and continu-
ously selling technical results to production units, which is the important
policy decision made by the central authorities with regard to conducting
reforms in the scientific and technological systems. It is hoped that
various leagues, cities, and the departments can work out a preferential policy

in the fields of financial affairs, credits and loans, tax revenues, and prices in order to enable enterprises to adopt new techniques and technology, to increase the variety of new products, and to enhance their purchasing of research results. Meanwhile, efforts should be made to open more scientific achievement markets of various categories at various levels.

3. A good job should be done in conducting the pilot work of delegating much self-determination power to research units.

4. A good job should be done in conducting reforms in the managerial system of mapping out scientific and technological plans.

5. A good job should be done in conducting the work of encouraging plants and enterprises to accept technical results and to enhance their development potentials. To make a success of this work, we should first open more lateral and regular channels between research units and production ones in order to promote coordination and cooperation between enterprises, research units, and higher educational institutions. In addition, efforts should be made to reinforce or enhance the capability of enterprises in developing technology.

6. A good job should be done in readjusting scientific research and bringing about rational arrangements in research.

7. A good job should be done in conducting reforms in the manager system for scientific and technological personnel and creating favorable circumstances in which people of talent come forth in large numbers and use their abilities to the fullest.

Xu Lingren stressed: Conducting reforms in the scientific and technological systems is an important strategic measure made by the CPC Central Committee. In order to make a success in the reform and to avoid shortcomings, we must strengthen the party's leadership over the work of conducting reform in the scientific and technological systems. The leading personnel of the party and governments at all levels should place the work of conducting reforms in this regard on their agenda of important items in order to grasp reform in the scientific and technological systems as they did reform of the economic system and to enforce the (?new system) in line with the demands set forth by the central authorities.

CSO: 4008/2025

NATIONAL DEVELOPMENTS

BRIEFS

BEIJING TECHNOLOGY CONTRACTS--At the national technological achievement trade fair, which lasted for 25 days and concluded on 10 June, some 15,000 contracts and letters of intent totaling some 8 billion yuan were signed. Beijing Municipality ranked second among all teams attending the fair in terms of the total transactions, which reached some 200 million yuan. [Excerpt] [Beijing BEIJING RIBAO in Chinese 11 Jun 85 p 1 SK]

CSO: 4008/2025

APPLIED SCIENCES

FAST GENERATION OF TWO-DIMENSIONAL BODY-FITTED CURVILINEAR COORDINATE SYSTEM

Mianyang KONGQIDONGLIXUE XUEBAO [ACTA AERODYNAMICA SINICA] in Chinese No 2, Jun 84 pp 1-10

[Article by Zhao Heshu [6392 7729 2579], Beijing Institute of Aeronautics and Astronautics: "Fast Generation of Two-dimensional Body-fitted Curvilinear Coordinate System Using Multi-Grid Method"]

[Text] Text of English Abstract: Multi-Grid (M-G) method and its application to solve a pair of non-linear equations generating two-dimensional body-fitted curvilinear coordinates are described. Some points concerning application of the method to such a problem are discussed. M-G is compared with G-S and SOR with an approximately optimum relaxation factor and shows that it is very efficient.

I. Introduction

A problem encountered when using the finite difference method to solve partial differential equations is that when the computational grid is adopted in the physical realm, the physical boundaries generally do not fit well with the grid nodes. If the method of interpolation is used between the nodes to give the boundary values, it is equivalent to incorrect processing in the most important area. To make the boundaries fall on the coordinate lines, Thompson[1] used a pair of the simplest oval equations, two Laplace equations, solved on the physical surface to generate a body-fitted curvilinear coordinate system. In this coordinate system, the boundaries themselves of any physical surface coincide with a coordinate, thus resolving completely the problem of boundary conditions given correctly in computations. Taking the oval equations first, one can freely designate all the boundary values. The solution of the Laplace equations is a tiaohe [6148 0678] function. The monotone of the tiaohe function in the region surrounding the boundary and the monotone of the boundary conditions we designate, ensure that the body-fitted coordinates will not overlap. After the above-discussed Laplace equations are transformed to the computed surface using the body-fitted curvilinear coordinate system as an independent variable, the computed grid can be taken as a uniform square. The body-fitted coordinate system is automatically generated from the conversion equation of the Laplace equation solved on this computed plane. After the aero-dynamic equation group has been transformed to this computed plane, the process of numerical solution is carried out on a uniform grid which is just what the finite difference method expects.

Thompson and his colleagues[2] solved some problems of viscid flow and inviscid flow around a two dimensional body using this body-fitted curvilinear coordinate system. Chen Nanxi [7115 0589 5409] and Zhang Qinan [1728 0796 0589][3] carried out tests on generation of body-fitted curvilinear coordinates in solving problems of two dimensional bukeyawei [0008 0668 1090 0143] flow. The computations of Zhang and Chen demonstrate that using the Successive Over Relaxation (SOR) iterative method recommended in [1] to generate this body-fitted curvilinear coordinate system is very time consuming and this reduces its useful value. In fact, except for the first few iterations, the convergence speed of any iterative method carried out in a single grid, is very slow and as the number of iterations increases, it becomes slower. The reason for this can be seen from the following simple analysis. We call the difference between the approximate value obtained after several iterations and the precise solution of the differential equation the error. This error can be displayed as a Fushi [4395 3044] series, that is, this error is made up of a great many components with different frequencies or "wave lengths." In the single grid iteration method, because there is only one grid spacing, the iterations can only effectively reduce the error component of that part of the same level of the "wave length" and the grid spacing. For even lower frequencies, i.e., those components with longer "wave lengths," since each relaxation step only involves the numbers of one point or the several neighboring points and the "wave length" of the grid spacing relative to this error component is too small, it is impossible to effectively reduce the error component of this part. Thus, after reducing the error component of same quantity of the "wave length" and the grid spacing, the speed of congruence becomes slower and slower. The Multi-Grid method is carried out by scattering the iterations in many grids of different spacing. The error component of different frequencies are reduced in grids of different spacings, and thus is very effective.

Brandt[4,5] has a systematic discussion of the Multi-Grid method. Fuchs and Zhao[6] used to solve three-dimensional viscous tubular flow. The aim of this paper is to explain, in the example of the generation equation a two-dimensional body-fitted curvilinear coordinate system, the basic principles and application of the Multi-Grid system and to provide a fast generation method for a two-dimensional body-fitted curvilinear system.

II. Body-fitted Curvilinear Coordinate System Generation Equation and Its Approximations

Based on the foregoing explanation, if things are done as in [1], we take the solution of a pair of Laplace equations at (x,y) of a physical plane

$$\xi_{xx} + \xi_{yy} = 0 \qquad (2.1a)$$
$$\eta_{xx} + \eta_{yy} = 0 \qquad (2.1b)$$

as the body-fitted curvilinear coordinate system, the boundary conditions which this solution should satisfy are

$$\left. \begin{array}{l} \xi = \xi_1(x,y) \\ \eta = \eta_1 \end{array} \right\} [x, y] \in \Gamma_1 \qquad (2.2a)$$

$$\left. \begin{array}{l} \xi = \xi_2(x, y) \\ \eta = \eta_2 \end{array} \right\} [x, y] \in \Gamma_2 \qquad (2.2b)$$

in which Γ_1 and Γ_2 are the physical surface boundary and the external boundary respectively; η_1 and η_2 are the two given constants, thus the physical surface and the external boundary are each one coordinate line; ξ_1 and ξ_2 are the monotonic functions selected at random along Γ_1 and Γ_2. The area D between Γ_1 and Γ_2 is the area which we ultimately will make flow field computations (see Figure 1). For the pipeline cross section, ξ_1, ξ_2, η_1, and η_2 are all designated by the boundary.

a. Physical plane   /   b. Transformation plane
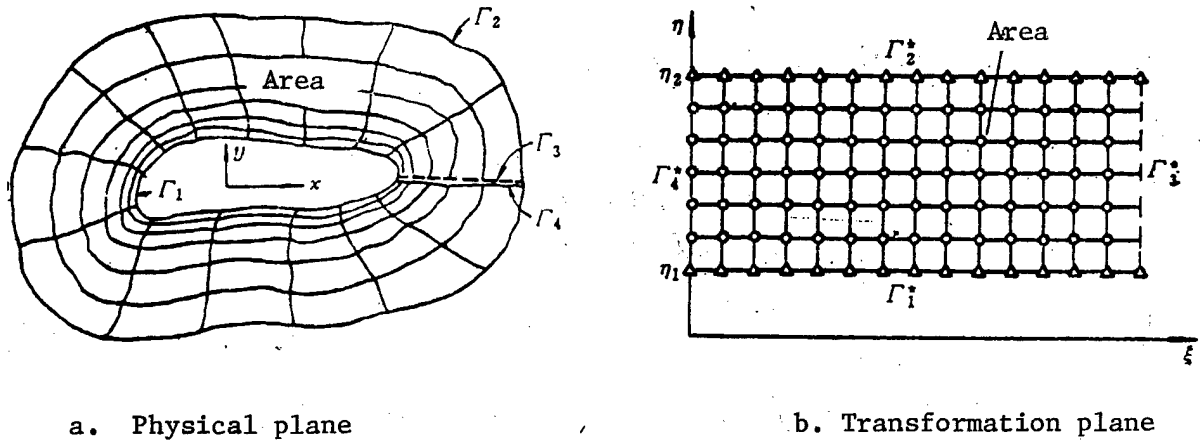
Fig. 1 Transformation of Field

Since when generating this body-fitted curvilinear coordinate system and when making flow field computations in the future we hope to avoid interpolating and to carry them out in a uniform grid, (2.1) and (2.2) are transformed to plane (ξ, η). Utilizing the coordinate transformation relationship

$$\left.\begin{aligned}
& \xi_x = \frac{y_\eta}{J}, \quad \xi_y = \frac{-x_\eta}{J}, \quad \eta_x = \frac{-y_\xi}{J}, \quad \eta_y = \frac{x_\xi}{J} \\
& \frac{\partial}{\partial x} = \frac{y_\eta}{J}\frac{\partial}{\partial \xi} - \frac{y_\xi}{J}\frac{\partial}{\partial \eta} \\
& \frac{\partial}{\partial y} = \frac{-x_\eta}{J}\frac{\partial}{\partial \xi} + \frac{x_\xi}{J}\frac{\partial}{\partial \eta}
\end{aligned}\right\}
\qquad (2.3)$$

in which Jacobi

$$J = x_\xi y_\eta - x_\eta y_\xi \qquad (2.4)$$

and assuming it is not zero, then (2.1) is transformed to

$$a x_{\xi\xi} - 2\beta x_{\xi\eta} + \gamma x_{\eta\eta} = 0 \tag{2.5a}$$

$$a y_{\xi\xi} - 2\beta y_{\xi\eta} + \gamma y_{\eta\eta} = 0 \tag{2.5b}$$

in which
$$\left. \begin{array}{l} a = x_{\eta}^2 + y_{\eta}^2 \\ \beta = x_{\xi}x_{\eta} + y_{\xi}y_{\eta} \\ \gamma = x_{\xi}^2 + y_{\xi}^2 \end{array} \right\} \tag{2.6}$$

boundary conditions (2.2) is transformed to

$$\left. \begin{array}{l} x = f_1(\xi, \eta_1) \\ y = f_2(\xi, \eta_1) \end{array} \right\} \quad [\xi, \eta_1] \in \Gamma_1^* \tag{2.7a}$$

$$\left. \begin{array}{l} x = g_1(\xi, \eta_2) \\ y = g_2(\xi, \eta_2) \end{array} \right\} \quad [\xi, \eta_2] \in \Gamma_2^* \tag{2.7b}$$

in which Γ_1^* and Γ_2^* are the correspondences of Γ_1 and Γ_2 respectively; f_1 and f_2 and g_1 and g_2 are determined by the physical surface boundary Γ_1 and the external boundary Γ_2 respectively; Γ_3^* and Γ_4^* are correspondences with Γ_3 and Γ_4 respectively; area D* corresponds to area D. Γ_3 and Γ_4 are artificial secants, the aim being to exclude the physical body outside of D*. The coordinate functions $x(\xi, \eta)$ and $y(\xi, \eta)$ and the airflow parameter at Γ_3 and Γ_4 are the same, and at Γ_3^* and Γ_4^* are also the same. Thus it is only necessary to compute the value of one of them. They are neither boundaries nor can they be given function values. In Figure (1b) the point with circles mean that they are points which require a value and the points with triangles are boundary points. The problem below is to solve the equation group (2.5) of the values in area D* which satisfy the boundary conditions (2.7). The grid of area D* can be of any design, though naturally, a uniform square grid would be easiest.

Now we will discretize (2.5). Second order derivative uses the standard five-point difference equation, the first order derivative uses the central difference, to obtain a difference approximation equation of (2.)

$$Lx = R_1 \tag{2.8a}$$

$$Ly = R_2 \tag{2.8b}$$

in which the difference operator L is

$$L = a\partial_{\xi\xi} - 2\beta\partial_{\xi\eta} + \gamma\partial_{\eta\eta}. \tag{2.9a}$$

in which.

$$\partial_{\xi\xi} = [(\ )_{i+1,j} - 2(\ )_{i,j} + (\ )_{i-1,j}]/h^2$$
$$\partial_{\xi\eta} = [(\ )_{i+1,j+1} - (\ )_{i+1,j-1} + (\ )_{i-1,j-1} - (\ )_{i-1,j+1}]/(2h)^2$$
$$\partial_{\eta\eta} = [(\ )_{i,j+1} - 2(\ )_{i,j} + (\ )_{i,j+1}]/h^2$$

(2.9b)

$$a = [(x_{i,j+1} - x_{i,j-1})^2 + (y_{i,j+1} - y_{i,j-1})^2]/(2h)^2$$
$$\beta = [(x_{i+1,j} - x_{i-1,j}) \cdot (x_{i,j+1} - x_{i,j-1})$$
$$+ (y_{i+1,j} - y_{i-1,j})(y_{i,j+1} - y_{i,j-1})]/(2h)^2$$
$$\gamma = [(x_{i+1,j} - x_{i-1,j})^2 + (y_{i+1,j} - y_{i-1,j})^2]/(2h)^2$$

(2.9c)

The right hand term in (2.8) is added because it is required by the Multi-Grid method (see below), in the densest single grid in which we want to obtain results, we take $R_1 = R_2 = 0$. Because the difference h of each layer of the grid is different, in the Multi-Grid method, it is necessary to design h into the difference equation. It is very clear that after adopting the above difference formula, (2.8) has second order precision.

III. Multi-Grid Method

1. Basic Thinking of the Multi-Grid Method

The relaxation iteration method is a frequently used indirect numerical solution method, especially for solving non-linear differential equations. The Multi-Grid method is also an indirect method. Its special characteristic is that it distributes the relaxation iteration process into a series of grids with different spacing and carries them out alternately. To simplify it, ordinarily, the grid spacing of the denser grids is made coarser by one half, i.e., $h^{k+1} = h^k/2$. What we ultimately want is the solution in the densest layer M. The greater the number of grids in the M layer the greater the number of layers it can be divided into.

On very obvious understanding of the advantages of the Multi-Grid method is: to solve the equations obtained in layer M, the equations can first be dispersed in layer (M-1) and relaxation iteration carried out, then interpolated back into layer M as an approximate solution in layer M. Because the grid points in layer (M-1) are much fewer than layer M, it thus saves computation time. By the same token, the approximate solution in layer (M-1) can be obtained from layer (M-2), and so on until the coarsest layer, layer k=1.

The transformation of the equations and their approximate solutions in each layer not only can be from coarser to denser layers. After the convergence speed has slowed in the denser layers, the coarser layers should be turned to carry out relaxation iteration by reducing the low frequency error. Therefore, the transformation of the equations and the approximate solutions between layers is carried out alternately until the densest layer has reached the precision demanded.

Because there is transformation between each layer, it provides us an opportunity to utilize the transformation process between each layer to improve the degree of approximation of the solution and more rapidly reach the precision demanded.

2. Transformation Between Layers

The transformation relationship of the equations and approximate solutions between layers is determined by the format used. The generally used formats are the Correction Scheme and the Full Approximation Scheme. We will explain them in the example of (2.8a).

<u>Correction Scheme</u> (CS) Let $\hat{x}^k$ be the precise solution of the difference equation (2.8a) dispersed in the k layer grid, x^k be the approximate solution or the active approximate solution, i.e., the solution obtained relaxation iteration to the time of discussion. Thus we have

$$L^k \hat{x}^k = R_1^k \qquad (3.1)$$

and $L^k x^k \ne R_1^k$. Notating the different of $\hat{x}^k$ and x^k as Δx^k, we get

$$\hat{x}^k = x^k + \Delta x^k \qquad (3.2)$$

thus (3.1) can be written as

$$L^k (x^k + \Delta x^k) = R_1^k \qquad (3.3)$$

If the difference operator L^k is linear, the above equation changes to

$$L^k x^k + L^k \quad x^k = R_1^k$$

or

$$L^k \Delta x^k = R_1^k - L^k x^k \equiv r^k \qquad (3.4)$$

in which r^k is the remainder, (3.4) is the remainder equation. Transforming this equation to layer (k-1), we get

$$L^{k-1} \Delta x^{k-1} = I_k^{k-1} r^k \qquad (3.5)$$

in which I_k^{k-1} represents the interpolation operation from layer k to layer (k-1). The left end need not be written $_L^{k-1} I_k^{k-1} \Delta x^k$ because we have not yet obtained Δx^k in layer k, Δx^{k-1} is the unknown function in layer (k-1). After solving (3.5) in layer (k-1) obtaining Δx^{k-1}, it is interpolated back to layer k, and utilizing (3.2) we get the solution x_{new}^k which is even closer to $\hat{x}^k$

$$x_{new}^k = x_{old}^k + I_{k-1}^k \Delta x^{k-1} \qquad (3.6)$$

(3.5) and (3.6) are the transformation relationship of the equation and the unknown function between any two neighboring layers. We see that in the coarsest layer (k-1), what we should solve is the equation of the layer k which is no longer dense but is the remainder equation. What is solved is not the unknown function x in the denser layer, but its correction value Δx, thus it is called the Correction Scheme. For just this reason, the transformation process between layers is also used to improve the degree of approximation and obtain the precision demanded more rapidly. It is very clear that when solving remainder equation (3.5), after its convergence rate slows, it can be transformed into a coarser layer (k-2) and be solved as a remainder equation, etc. In each layer, the operators L^k are the same, the only difference being the grid spacing and the right hand term of the equation, thus the same relaxation computational process is suited for all layers and this makes it easy to write the program. In the above deduction, the section in which L^k is used as linear, strictly speaking, this correction scheme is suited only for linear equations.

Full Approximation Scheme (FAS) (3.1) to (3.3) are still suited for use in this format. $L^k x$ is substracted from both sides to get

$$L^k(x^k + \Delta x^k) - L^k x^k = R_1^k - L^k x^k \equiv r^k \tag{3.7}$$

transforming this equation to the layer (k-1), we get

$$L^{k-1} (I_k^{k-1} x^k + \Delta x^{k-1}) - L^{k-1} (I_k^{k-1} x^k) = I_k^{k-1} r^k \tag{3.8}$$

we define a new unknown function $\tilde{x}^{k-1}$, i.e.,

$$\tilde{x}^{k-1} = I_k^{k-1} x^k + \Delta x^{k-1} \tag{3.9}$$

thus (3.8) changes to

$$L^{k-1}\tilde{x}^{k-1} = I_k^{k-1} r^k + L^{k-1} (I_k^{k-1} x^k)$$
$$= K_k^{k-1} (R_1^k - L^k x^k) + L^{k-1} (I_k^{k-1} x^k) \tag{3.10}$$

This is the equation which should be solved in layer (k-1), the right hand term comes from layer k, therefore it is known. After finding $\tilde{x}^{k-1}$, because we have (3.9) we can obtain Δx^{k-1}. Interpolating it to layer k, and utilizing (3.2) and (3.9) we can get a solution x_{new}^k which is even closer to $\hat{x}^k$,

$$x_{new}^k = x_{old}^k + I_{k-1}^k \Delta x^{k-1}$$
$$= x_{old}^k + I_{k-1}^k (\tilde{x}^{k-1} - I_k^{k-1} x^k) \tag{3.11}$$

(3.10) and (3.11) are the transformation relationship of the equation and the known function between any two neighboring grid layers. This format does not demand that the operator L^k be linear, but it is suited to non-linear equations. From (3.9) and (3.11) it can be seen that in addition to including the current

approximation solution of the denser layer, the function found in the coarser layer also has its correction, thus the transformation process between layers is also used to improve the degree of approximation of solutions. Because what is found in each layer is only an approximate solution correction and is the unknown function itself, therefore it is called the Full Approximation Scheme. The superscript in $\tilde{x}^{k-1}$ in (3.1) can be dropped so that it is written x^{k-1}, because both represent the unknown functions of the unknown function layer, thus (3.10) and 3.11) are respectively

$$L^{k-1}x^{k-1} = I_k^{k-1} (R_1^k - L^k x^k) + L^{k-1}(I_k^{k-1}x^k) \tag{3.12}$$

$$x_{new}^k = x_{old}^k = I_{k-1}^k(x^{k-1} - I_k^{k-1}x^k) \tag{3.13}$$

Below we explain that the transformation relationship between the layers discussed above in essence is the influence of the error of the partial truncation counted to. Everyone knows that the basic factor of the influential partial truncation error is the grid spacing h. In the Multi-Grid method, because the h of different layers is different, we simply disperse the same differential equation in similar form in the layers, and since the partial truncation error of the layers is different, the solution in the coarse grid generally is not an approximation of the solution in the dense grids. If we let X represent the precise solution of the differential equations discussed, and τ represent the partial truncation error, and substitute X in the difference equation (2.8a) we get the partial truncation error of layer k and layer (k-1).

$$\tau^k = L^k X^k - R_1^k \tag{3.14}$$

$$\tau^k = L^{k-1}X^{k-1} - R_1^{k-1} \tag{3.15}$$

thus the relative partial truncation error of layer (k-1) relative to layer k is

$$\Delta \tau^{k-1} = \tau^{k-1} - I_k^{k-1}\tau^k$$
$$= L^{k-1}X^{k-1} - R_1^{k-1} - I_k^{k-1}(L^k X^k - R_1^k) \tag{3.16}$$

Because $\Delta\tau^{k-1}$ is a relative value, the above equation can use the following equation for approximating

$$\Delta \tau^{k-1} \approx L^{k-1}x^{k-1} - R_1^{k-1} - I_k^{k-1}(L^k x^k - R_1^k) \tag{3.17}$$

The aim of the computations in layer (k-1) is to obtain the approximate solution of layer k. To compute the influence of this relative partial truncation error, we should substract $\Delta\tau^{k-1}$ in the difference equation of layer (k-1), that is, the equation to be solved in layer (k-1) is

$$L^{k-1}x^{k-1} - \Delta\tau^{k-1} = R_1^{k-1}$$

or

$$L^{k-1}x^{k-1} = \Delta C^{k-1} + R_1^{k-1}$$

$$= L^{k-1}I_k^{k-1} + I_k^{k-1}(R_1 - L^k x^k) \qquad (3.18)$$

that is, (3.10). Thus, the essence of changing the equation's right hand term in the coarser grid is to compute the influence of the partial truncation error.

3. Computational Steps

First of all, we design the grid. Any number of grids can be taken for the coarsest layer (k=1), below each layer is double that of the one above. In this paper, the number of grids in the first layer is 4x3. For problems of wing shapes we use all together five layers, for problems of tube cross sections we use all together four layers, thus the number of nodes in the densest layer I^M_{max} x J^M_{max} are 65 x 49 and 33 x 25, respectively.

Next is to fu [6346] the boundary values of the densest layer according to (2.7). For wing-shape problems, f_1 and f_2 are given from the wing surface coordinates; g_1 and g_2 are determined by circle of chord point eleven-fold chord line in the spacing. For tube cross-section problems, all are determined by the cross-section boundaries.

Because the equation (2.8) to be solved is non-linear, to ensure iteration convergence, it is necessary to provide appropriate initial values. According to the experience of [1], utilizing authoritative averages of the boundary values to provide the initial values, for the wing-shape problem they are

$$x^M_{i,j} = \left(\frac{J^M_{max} - j}{J^M_{max} - 1}\right) x_{i,1} + \left(\frac{j-1}{J^M_{max} - 1}\right) x_{i,J^M_{max}} \qquad (3.19a)$$

$$y^M_{i,j} = \left(\frac{J^M_{max} - j}{J^M_{max} - 1}\right) y_{i,1} + \left(\frac{j-1}{J^M_{max} - 1}\right) y_{i,J^M_{max}} \qquad (3.19b)$$

The computations below are carried out alternately in the following three steps, i.e., relaxation, transformation from denser to coarser, and transformation from coarser to denser. These are the three important constituent parts of the Multi-Grid method. The computations in this paper begin from the densest layer.

(A) Relaxation using the Gauss-Seidel relaxation method, we carry out relaxation of (2.8a) and (2.8b), respectively. And we compute the error and the convergence rate. Here, error is defined as

$$e^k = \sqrt{0.5 \left(\sum_i \sum_j (\Delta x^k_{i,j})^2 + \sum_i \sum_j (\Delta y^k_{i,j})^2\right) / 4^{M-k}} \qquad (3.20)$$

in which the superscript k represents the k'th layer, Δx_{ij}^k and Δy_{ij}^k are the difference between $x_{i,j}^k$ and $y_{i,j}^k$ before and after relaxation; the summation range is the overall evaluation point; 4^{M-k} is introduced to facilitate comparing layer error. In the densest layer it is 1. The convergence rate is defined as

$$\mu^k = e_{new}^k / e_{old}^k \qquad (3.21)$$

i.e., the ratio of the error before and after relaxation.

If k-M and e^M is smaller than the permitted error ε^m of layer M, then the computations are completed.

If $k < M$, and the convergence rate is still pretty fast, i.e., $\mu k < \bar{\eta}$, then return to step (A) and relax in the same layer again until $e^k \leqslant \varepsilon^k$ then go on to step (C). The size of $\bar{\eta}$ is related to the nature of the equation. For the nonlinear equations in this paper, $\bar{\eta} = 0.8$, $\varepsilon^k = 0.2 \varepsilon^{k+1}$.

If $k \lessgtr M$, and the convergence rate has already slowed, then go on to step (B).

If k=1 or is equal to the coarsest layer indicated, then return to (A) regardless of whether the convergence rate is fast or slow.

In the relaxation process, this paper carried out linear condensation processing, i.e., the coefficients of Eq. (2.8) α^k, β^k and γ^k were maintained in each relaxation scan. The author tested three condensation methods. One was to compute a new α^k, β^k and γ^k and replace the old ones after each relaxation scan in a layer. Another was to do linear relaxation in each layer, and after each relaxation scan, compute the three coefficients for each point and replace the old ones. And the other method was to compute new coefficients after completing a relaxation scan only in the densest layer, the three coefficients in the coarsest layer were computed using (2.9c) after interpolation for that layer from x^M and y^M of the densest layer. Test results showed that the convergence of the latter was fastest.

(B) Going from the densest grid layer to the coarsest grid layer   First interpolate x^k and y^k for layer (k-1), i.e.,

$$x^{k-1} \longleftarrow I_k^{k-1} x^k$$
$$y^{k-1} \longleftarrow I_k^{k-1} y^k \qquad (3.22)$$

then evaluate the right hand term of the equation that gives layer (k-1) according to (3.10). Finally, return to (A) and carry out relaxation in layer (k-1).

(C) Going from the coarser grid layer to the denser grid layer   Use the x^k and y^k obtained in layer k to carry out interpolation by (3.13), to obtain the x^{k+1} and y^{k+1} in layer (k+1). Then go on to (A) and carry out relaxation in layer (k+1).

The interpolation operators, I_k^{k-1} and I_k^{k+1}, generally should be of the same order as the equation, second order equations use second order interpolations. To simplify things, this paper uses linear interpolations entirely, and the overall effect is still good (see conclusions). Only after increasing the number of reduction iterations to a certain value, we do not go on to the first and second layer to avoid cumulative influence introduced by linear interpolations.
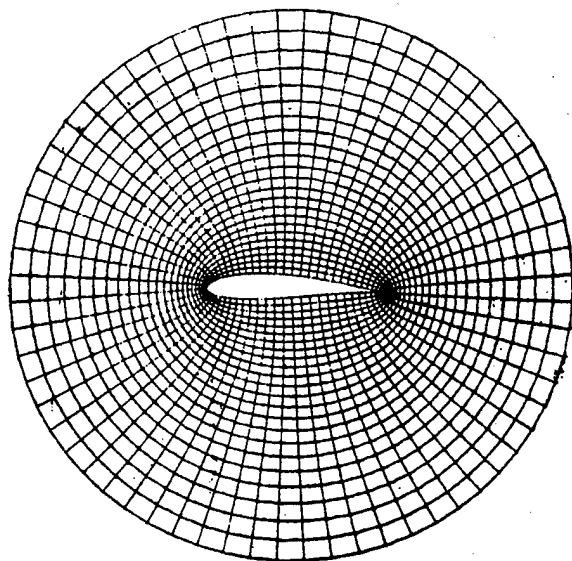
Fig. 2   Body-fitted Curvilinear
         Coordinate System of Wing
         Shape (partial field)
         (Karman-Trefftz wing shape)
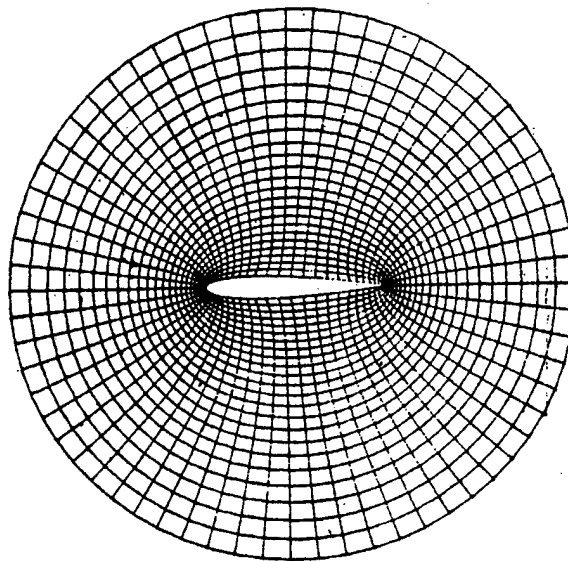
Fig. 3   Body-fitted Curvilinear
         Coordinate System of Wing
         Shape (partial field)
         (NACA 0012)
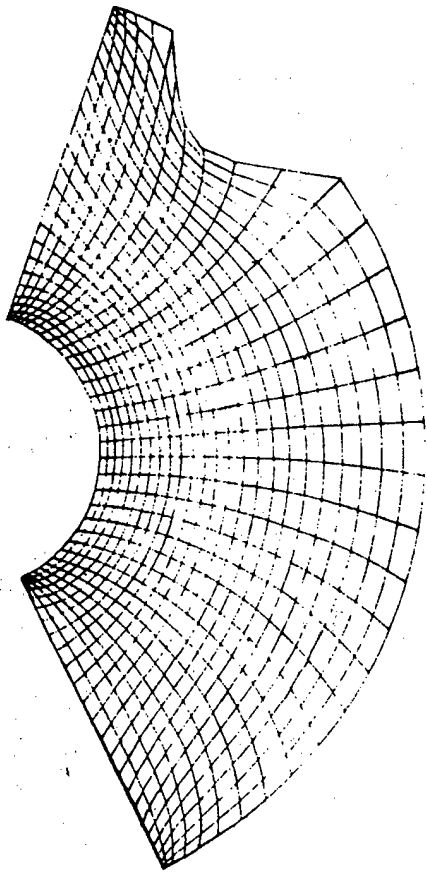
Fig. 4 Body-fitted Curvilinear
        Coordinate System of
        Tubular Cross Section
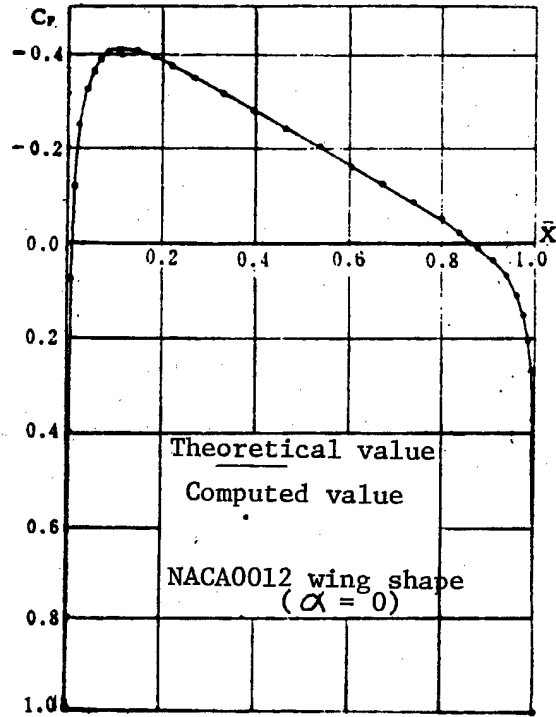
Fig. 5 Pressure Distribution on
        Wing Shape Surface (NACA 0012)

IV. Conclusion and Discussion

The Multi-Grid method discussed above in this paper was used to solve equations
of Karman-Trefftz and NACA0012 wing shapes and the cross section of tube at any
location (2.8). The body-fitted coordinate system generated is illustrated in
Figures 2 to 4. Figures 2 and 3 only provide part of the coordinate system.

To check the accuracy of this method, under this coordinate system, we used
the Multi-Grid method to compute the pressure distribution of the two wing
shapes and compared the theoretical value and the analytical solution, see
Figures 5 and 6. The departure equation of the computations was the same as
[2]. In using the interpolation method to find the trailing edge speed aspect,
this paper preserves the second order derived term. For the NACA0012 wing
shape (including the angle of attack situation), this article determined the
ring using the trailing edge speed as zero. For the Karman-Trefftz wing shape,
the trailing edge speed of the upper and lower wing surfaces were equally used
to determine the ring. The theoretical values in Figure 5 were taken from
unpublished computational results from Northwest Industrial University. It is

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more accurate than the standard data from the 'forties (see NACA TR 824). The theoretical results in Figure 6 were computed by the author using the Karman-Trefftz redraft. From these two figures it can be seen that the computed value and the theoretical or analytical value fit extremely well, i.e., there are no exceptions at any point in the vicinity of the leading edge or the trailing edge.

On the assumption that the computational results are correct, this paper emphasizes checking the effectiveness of the Multi-Grid method (M-G). The results are given in Figure 7, in which three methods are plotted, i.e., the convergence of the Gauss-Seidel Relaxation Iteration Method, the Successive Over Relaxation Iterative Method (SOR), and the Multi-Grid Method. The relaxation factor in the SOR method ω was 1.75. According to [3] this is the optimal value of the body-fitted curvilinear coordinate system which generated NACA 0012. All three methods use the same relaxation program (for G-S and M-G ω =1.0), as many grid points (65 x 49), and the same initial value. In the figure, the vertical coordinate is the comparison of the error EER (See (3.20)) and the error (ERR)^1 after the first relaxation scan. The horizontal coordinate W is the number of work units, also referred to as the frequency of reduced iterations, defined as

$$\tag{4.1}$$

in which N^k is the frequency of relaxations in the k'th layer. Since the number of grid points in the k'th layer is $1/(4^{M-k})$ fold of the densest layer (M), W is equivalent to computing by reducing the frequency of iterations in the layer to the densest layer. From the figure it can be seen that for the non-linear equation (2.8) we are discussing, relaxation iteration was carried out 150 times, the G-S method only reduced the error to 0.66 of the initial error, the SOR method which had the optimum relaxation factor only reduced it to 0.084, but with only 93 times, the M-G method reduced it to 0.0001 of the initial error. It can be seen that it is very effective.

Although these three methods are fairly accurate comparing them with the frequency of reduced iterations W as a basic standard, they were not affected by programming skill, but it was not very rational either because the transformations between layers in the M-G method is very time-consuming. However, the time lost in transformations between layers is not great, generally increasing 20 percent. Even being more conservative, and compute two W's for each transformation to a coarser layer and from coarser layer to the densest layer, to achieve (ERR)/(ERR)^1 = 0.0001 would not take as many as 150 W's. Figure 7 forcefully demonstrates the superiority of the Multi-Grid Method.
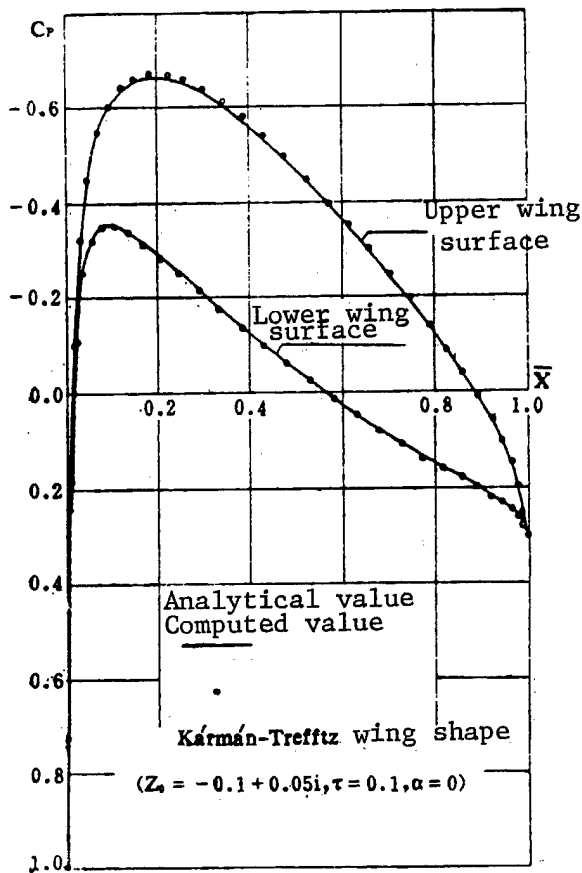
Fig. 6   Pressure Distribution on
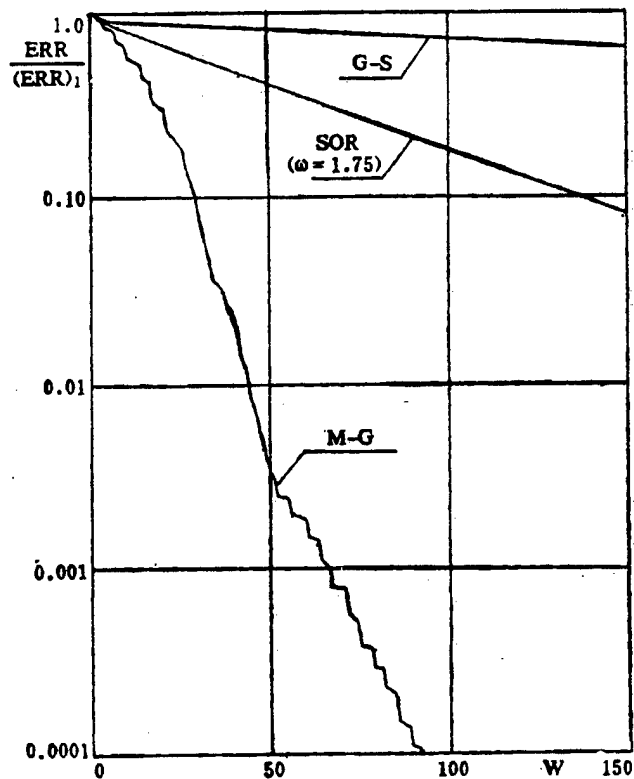Wing Shape Surface
(Karman-Trefftz)

Fig. 7   Comparison of Convergence Speed
of the Three Methods

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APPLIED SCIENCES

NON-DESTRUCTIVE ULTRASONIC TESTING OF PROPELLANT IN SMALL SOLID ROCKET MOTOR

[Article by Guo Chongxiong [6753 6850 7160], Nan Dapeng [0589 1129 7720], and Zhu Chunliang [2612 2504 5328], Applied Physics Department: "Non-destructive Ultrasonic Testing of the Propellant in a Small-sized Solid Rocket Motor"*]

[Text] Text of English Abstract: With the help of the ultrasonic transmission technique, a nondestructive ultrasonic testing device has been developed to detect debonds, voids, and cracks of the propellant in a small sized solid rocket motor. A focused ultrasonic beam is utilized to make a penetrating scan into the propellant surface spirally, and then the location of defects may be realized, the defects themselves identified semi-quantitatively, and the propellant surface expansion diagram obtained. To avoid employing the couplant, a special oil-filled dry ultrasonic coupler has also been developed.

The experimental results showed that the coupling was stable and its effects were workable.

The method is also applicable for nondestructive testing of other non-metals and composite materials.

I. Introduction

"Small solid rocket motor loaded powder cylinder" is a solid propellant powder cylinder (hereafter, powder cylinder). It is made up of a solid propellant cylinder covered on the outside by one (or two) layers of covering 1-2 mm thick. In between the propellant and the covering there is a bonding agent. The structure is illustrated in Figure 1.

Figure 1. Diagram of powder cylinder structure
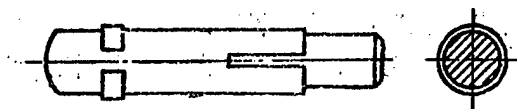
Figure 7 is of a test of the powder cylinders of a plant. In testing, 3∅ 1 mm voids were discovered under the powder cylinder's covering and on dissecting the powder cylinder at the plant, the results conformed with the testing completely.

Figure 8 presents the results of a test on the powder cylinder of a plant. In testing, two debondings A and B were discovered and on dissection by the plant, A was a debonding between the first covering and the second covering while B was a debonding between the second coverings and the powder cylinder.

Figure 7. Illustration of small void   Figure 8. Illustration of natural debonding

∅1 voids
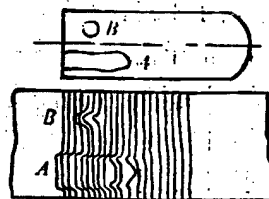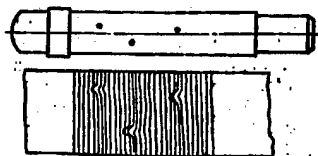
V. Conclusion

Testing proves that the ultrasonic powder cylinder testing method described in this paper, is very sensitive, is accurate, and can semi-qualitatively analyze the size of defects, it is simple to operate, safe and reliable, and is an effective method for powder cylinder testing. It can also be used for nondestructive testing of other non-metallic and composite materials.

In carrying out the work in this paper, we were greatly assisted by the Ministry of Ordnance's 375 and 245 plants, Ministry of Astronautic's 7013 and 7416 plants, the Yingkou Instrument Plant, and the Harbin Northern Rubber Plant and here we express our deepest thanks.

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Because the design and use department demands ruled out the use of watery or oily couplants in testing powder cylinders, the authors developed two types of oil-filled focused dry coupler probe, and experimental results demonstrate that the performance of these two coupler probes is excellent and they are easy to use.

The principles of the ultrasonic testing method are illustrated in Figure 2.

Figure 2. Diagram of test principles

Key:

a. powder cylinder rotation
b. emitter probe
c. receiver probe
d. vibration sensor
e. ultrasonic generator
f. translation wire rod
g. heterodyne frequency selector amplifies test wave
h. signal processing
i. pen recorder
j. probe translation
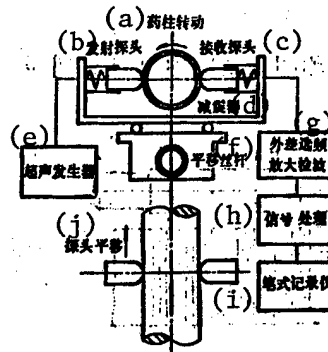
The mechanical scanning device turns the powder cylinder and moves the probe horizontally along the axis of the powder cylinder, thus making the emitter probe and the receiving probe spiral along the surface of the powder cylinder simultaneously and relatively to scan the powder cylinder. The emitter probe's ultrasonic beam penetrates through the powder cylinder then is focused on the back surface of the powder cylinder. The signal output by the receiver probe after going through a heterodyne frequency selecting amplification, detection, and filtering, is processed by a microcomputer and the results are recorded by a pen-type recorder.

III. Dry Couplant Probe

For ultrasonic detection, the use of a couplant is very important. For general ultrasonic detection, the couplant is spread on the test object surface or it is carried out with the test object immersed in the couplant. Since the powder cylinder cannot come in contact with the couplant, the ordinary coupling methods cannot be used, the dry couplant probe was developed.

The dry couplant probe we developed combines the direct contact method and immersion method of ultrasonic detection, i.e., we use a soft contact immersion probe. The ultrasonic beam produced by the focusing probe is emitted through the coupler oil and the entire probe makes elastic contact from the rubber film and the object being tested, and since the rubber film has excellent elasticity, when appropriate pressure contacts the test object surface, it both can make an excellent fit with the test object and can slide (or roll) along the surface of the test object and achieve dry coupling goal.

According to the demands of testing powder cylinders and the specific situations, two dry coupling probes were developed, a cap-type probe and a wheel-type probe, as illustrated in Figures 3 and 4.
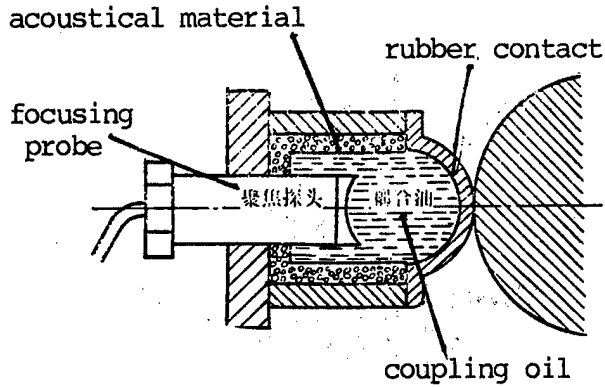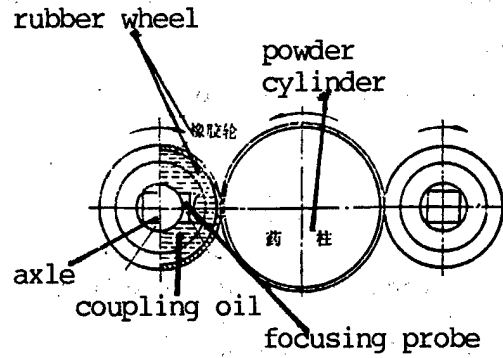
Figure 3. Cap-type probe   Figure 3. Wheel-type probe

acoustical material

rubber contact

focusing probe

coupling oil

rubber wheel

powder cylinder

axle

coupling oil

focusing probe

To ensure the stability of the dry coupler state, the dry coupler probe is installed on the mechanical scanning device by a spring system so that contact pressure must be suitable.

The focused probe was designed according to the acoustical characteristics of the coupler oil, rubber film and the powder cylinder being tested and when the acoustic beam focal point is in the vicinity of the receiving probe and the powder cylinder contact point, sensitivity for detecting covering debonding is optimal.

Generally, for testing small powder cylinders with diameters of 30-60mm where the demands for testing small defects are high, the cap-type probe is used and for larger powder cylinders, the wheel type probe is used.

IV. Test Examples

The mode CS-A ultrasonic tester has been used by the Ministry of Astronautics and the Ministry of Ordnance for testing several types of powder cylinders.

Figures 5 and 6 show ultrasonic test pictures of powder cylinders manufactured by a factory with artificial defects. From the figures the 3 x 3mm^2 artificial defects and artificial cracks can be seen.

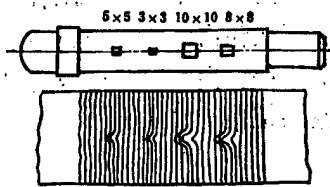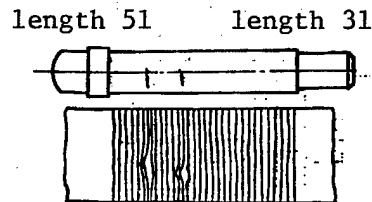Figure 5. Illustration of artificial   Figure 6. Diagram of artificial cracks
           debonding

5x5 3x3 10x10 8x8

length 51   length 31

Depending on the product requirements, in between the propellant cylinder and the covering and between covering and covering, there must be good bonding and debonding of a certain area not permitted and within the propellant, cracks and bubbles of a certain size not permitted. To ensure the quality of the propellant, so that after ignition the motor will operate normally and without accident, non-destructive testing of the powder cylinder is necessary.

X-ray, infra-red, and laser holography methods are now used for testing for internal defects and covering debonding of the powder cylinder. In this article, the authors introduce an ultrasonic testing method which they have recently researched. Its advantages are that it is very sensitive and can test for covering debonding and defects within the powder cylinder at the same time. The model CS-A semiautomatic ultrasonic tester developed has passed official appraisal in which relevant units of the Ministry of Astronautics, Ministry of Ordnance and Ministry of Aeronautics participated and it has been acknowledged as having achieved advanced domestic levels.

The technical performance features of the model CS-A ultrasonic tester are:

1. Covering debonding: can detect debonding above $3 \times 3mm^2$

2. Internal defects: can detect voids of more than 3mm or equivalent and can detect cracks

3. Recording method: makes permanent record using a drum type recorder.

II. Testing Principles

Solid propellant is a high polymer composite. It is very good at attenuating sonic waves and as the ultrasonic frequency increases, the attenuation co-efficient increases. Because the working frequencies of current general purpose reflectoscopes are high, they are not suited to testing of powder cylinders. Low frequency ultrasonic waves have better transmission properties in propellant, but are not good for detecting small defects, thus to ensure that the ultrasonic waves can be better transmitted in the powder cylinder as well as detect the smallest possible defects, it is necessary to select the appropriate working frequency. Through measurement in a solid propellant, the wave length of a longitudinal ultrasonic wave of a frequency of 200-300 KHz at a sonic speed of about 1700 m/sec (for different types of propellants, the sonic speed differs) was computed at approximately several mm, and was capable of detecting defects with lines of 3mm. Through experiments, using dry couplant probe, when 3 watts of power was input to the emitter probe, after a 200 KHz ultrasond penetrated a 60mm powder cylinder, the voltage signal received by the receiving probe reached several mV, which was very easy to detect. Thus, it is feasible to test a small powder cylinder using 200-350 KHz ultrasound.

Since the ultrasonic penetration method has the advantages of being suited to testing materials with large sonic attenuation, being easy to use for recorders and for signal processing, and easy to carry out continuously and automatically on large groups of objects which are simple in shape, this ultrasonic testing uses the penetration method.

APPLIED SCIENCES

SYSTEM LOAD, PATTERN OF MULTIDIMENSION NODE LOAD FORECASTING

[Article by Guo Zhizhong [6753 1807 1813], and Liu Zhuo [2692 8743], Electric Power Industry Automation Laboratory and Fang Gongshou [2455 1872 1108], Anhui Electric Power Central Dispatch Office: "System Load and Pattern of Multidimension Node Load Forecasting"*]

[Text] Text of English Abstract: In this paper the node load has been described by means of its numerical characteristics--the node load rate and its Q-P ratio. On the basis of the system load forecasting, a method of node load pattern forecasting has been presented. Combining the node load forecasting with the node load pattern forecasting, this method becomes very useful for the numerical calculation and the application of some software in the power system.

I. Introduction

Currently, applications software for safety analysis, on-line current and optimal current can meet the practical demands for scale and operational speed in solving problems.[1,2,3] From the angle of on-line application, continuing to expand the solution scale and to improve operation speed is still very important. However, this application software requires future node load data and if computations and research on the future situation of power systems is not carried out it cannot have any foresight and will be unable to take preventive measures.

In China, forecasting electric power system node loads has begun to attract the attention of electric power science workers. Although individual dispatch centers are equipped with periodic artificial songshu [6623 2422] electric power system dispatch operations data bases, node load data is still not sufficiently complete and it is very difficult to use purely statistical methods for node load forecasting. For this reason, on the basis of overall active power load forecasting, this article improves on the vector smoothing method[4] to obtain node active load forecasts for the three daily time intervals

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*Article received January 1985.

of early peak, late peak and valley; then with the aid of the overall active power load curve and the node load Q-P ratio we obtain the node load pattern forecast for the 24 daily time intervals. For a few important nodes, the statistical method is used for forecasting the node load and for the other general nodes, the forecasting is carried out using the pattern method.

II. New Information Self Adjusting System Power Load Forecast Based on Analysis of Quantity of Electricity

The overall load sequence of an electric power system is a non-stable time sequence and it must be processed to a stabilized one. This article uses a stable term extraction method based on analysis of quantity of electricity and carries out primary differential processing on the remaining terms to obtain a stable random time sequence.

Document [5] proposes a method for revising the quantity of electricity of a power load forecast. This article does not use the daily quantity of electricity to revise the load forecast value, but obtains a stable term based on the analysis of the quantity of electricity.

The quantity of electricity of the i'th day

$$W_i = \int_0^{24} P_i(t) \cdot dt \tag{1}$$

in which W_i is the daily quantity of electricity

$P_i(t)$ is the overall active power load of the system

If we take 1 hour as the time interval, we have

$$W_i \doteq \sum_{j=1}^{24} P_{ij} \tag{2}$$

in which P_{ij} is the over all active power load of the i'th day's j'th time interval

Eq (2) can be changed to

$$\sum_{j=1}^{24} P_{ij}/W_i = 1 \tag{3}$$

let

$$C_{ij} \equiv W_i/P_{ij} \tag{4}$$

and we have

$$\sum_{j=1}^{24} C_{ij}^{-1} = 1 \tag{5}$$

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Cheng [4468] $\{C_{ij}\}$ (j=1,2,...,24) is the i'th day's load ratio sequence.

The load ratio sequence reflects the wave regularity of the daily load (Figure 1). At the same time, it also reflects the size of the time interval load's (P_{ij}) influence on the quantity of electricity (W_i). The accumulated value W_i of P_{ij} cancels the P_{ij} value with different changes of j, but C_{ij} preserves this change. Eqs (2) and (5) demonstrate that between W_i, P_{ij}, and C_{ij} there exists a clear mathematical physical relationship.
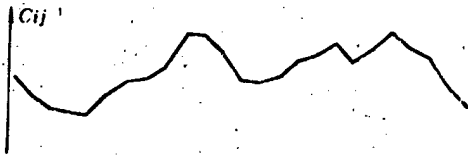

Figure 1

C_{ij}min and the daily load rate express similar physical meanings and one can see the $\{C_{ij}\}$ sequence extends the daily load rate concept each time interval.

This paper uses the adaptive smoothing pattern[6] which takes up little memory and is a simple method to forecast the quantity of electricity W_{i+1} and the load ratio sequence $C_{i+1\ j}$ and finds the forecast value of the stable term.

$$\hat{B}_{i+1 \cdot j} = \hat{C}_{i+1 \cdot j} \cdot \hat{W}_{i+1} \qquad (j = 1,2,\cdots,24) \tag{6}$$

for the remaining term

$$Z_k = P_k - B_k \qquad (k = 1,2,\cdots,k,\cdots) \tag{7}$$

primary difference is carried out

$$\omega_k = (1 - B)Z_k \tag{8}$$

and $\{\omega_k\}$ is seen as a stable random time sequence. β in Eq. (8) is the difference operator.

Through pattern estimation,[7] $\{\omega_k\}$ is accepted as the ARMA sequence. Because the high order MA patter can approximate the AR and ARMA patterns, and adopting the new information forecasting method proposed in document [8] one can have a simple expression and the operation can be simplified, thus in this article we adopted the new information adaptive forecasting method of the MA sequence to forecast .

The stable forecast of the ARMA sequence is based on the complete historical data $\omega_k, \omega_{k-1}, \cdots$ yielding the linear minimum estimated variance of ω_{k+1}. But in actual forecasting, when the smoothing average pattern MA's step q>0, we can only compute an approximation of the linear minimum estimated variance ω_{k+1}. However, when there is limited historical data, the new information adaptive forecasting method gives the strictly linear minimum estimated variance of ω_{k+1}

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and makes it the forecasting value and gives the recursive suanshi [4615 1709] of the forecasting value as k increases.

The results of actual forecasting show that under normal circumstances, precision using the overall active power load forecasting in this article, precision generally can satisfy the demand of an error of less than 5 percent.

The analytical quantity of electricity method combines the features of regularity of the rise and fall in the overall load of an electric power system and takes into consideration the interrelationships of daily interrelationships and time difference interrelationships, and thus makes the overall active power load forecasting method in this paper more precise.

Using the new information adaptive method to forecast random terms requires only that a pattern be established. There is an interdependent relationship in the forecast values between individual time intervals which lowers the error in forecast values due to accidental occurrences.

III. Digital Characteristics of Node Load

Because types of loads are different, changes in node loads are different. In medium- and long-range regional load forecasts used in power system planning the following method is employed,[9] the loads are divided into industrial, commercial, and residential types according to the different nature of the loads and the proportion of the load occupied by each type in a region determines the load fluctuation for that region. In addition, in recent years, in the Soviet Union experimental researches have been undertaken on power system node loade probability statistics.[10] For short-range node load pattern forecasting, this method has some reference value. In fact, no matter what node, the load consists only of the combination of asynchronous dynamo types and impedance types. The difference is that the constituent proportions are different so that the use conditions are different. Through analysis of actual node loads, we find that two digital characteristics of node loads can be used to characterize the nature of node loads: node load rate and node load Q-P ratio.

1. Node load rate

The node laod rate of an electric power system is given according to the following equation:

$$r = \frac{W}{24 \cdot Pmax} \cdot 100\% \qquad (9)$$

in which W is the daily quantity of electricity

   Pmax is the maximum active power load

In a provincial regional power network dispatch center, we generally cannot obtain the entire node load for 24 time intervals, but only have the node active load values for the three time intervals of early peak, late peak, and

valley. Statistical results show that the fluctuations of node active load is generally the same as the fluctuations in system load, the differences being mainly in degree of fluctuation. Thus, in engineering, the node load rate is computed according to the following equation:

$$\overline{\gamma} = \frac{W}{24 \cdot MAX \{P \text{ early peak}, P \text{ late peak}\}} \cdot 100\% \tag{10}$$

$\overline{\gamma}_i$ is the node load rate of the j node.

From (9) and (10) it is not hard to see that the node load rate reflects the fluctuations of node load. When the node load rate gets close to 1 it means that the node load is comparatively stable, and as the node load rate gets smaller, it means that the node load fluctuations are increasing.

For nodes where the industrial load is proportionally great, $\overline{r}_i$ is higher (node A in Table 1) and for nodes where the non-industrial load is proportionally great, $\overline{r}_i$ is lower (node B in Table 1).

Table 1. Early peak is 9 o'clock, late peak is 18 o'clock

Node \ Day	1	2	3	4	5	6	7	average
Node A	96.9	109.4	98.1	90.2	97.1	97.9	96.6	98.0
Node B	61.0	71.8	85.3	71.7	76.6	66.7	84.6	74.8

2. Node load Q-P ratio

Here defined as

$$\beta_{ij} = \frac{Q_{ij}}{P_{ij}} \tag{11}$$

in which Q_{ij} and P_{ij} represent the idle node load and node active load of the i'th node in the j'th time interval

β_{ij} is the Q-P ratio of the i'th node in the j'th time interval.

In some computational problems of electric power systems, idle node load data is required. The historical data is much less for idle node load than for node active load, and using statistical methods to analyze and forecast idle node load is difficult.

Node load is frequently made up of asynchronous dynamo type and impedance type load and the node load Q-P ratio reflects the proportion of the above two types of load in the node load. Each asynchronous dynamo can have different operating modes, such as start up, no-load, light-load, full-load, ..., but in general, these masses of asynchronous dynamos have comparatively stable statistical regularity, and their Q-P ratio is fairly stationary. Except for the evening illumination time intervals* [*the evening illumination time intervals refers to the 18th, 19th, 20th, and 21st time intervals], the increase or decrease in the active load of the node load is primarily caused by the increase or decrease of the number of asynchronous dynamos in operation, this means an increase or decrease of the idle load, and taking into consideration that the impedance load makes up a certain proportion of the node active load, causes an increase or decrease of the node load Q-P ratio. There are differences with the evening illumination time intervals. At this time the increase in the node active load is primarily cause by use of electricity for illumination but the

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idle power proportion of electricity used for illumination is small, thus the node load Q-P ratio at this time decreases (Table 2).

Table 2. Q-P ratio of one day's node load for one node

Time interval	1	5	9	10	12	15	18	20
active node	320	300	405	428	374	450	403	468
Q-P ratio	0.297	0.283	0.432	0.477	0.371	0.433	0.372	0.333

Therefore, in the statistical sense, the following equation can be used to express the Q-P ratio of the node load

$$\beta_{ij} \doteq \beta_{oi} - a_i (P \text{ early peak} - P_{ij}) \tag{12}$$

in which β_{oi} is the stable part of the node load Q-P ratio of node i

P_{ij} is the node active load of node i in time interval j

a_i is the fluctuation coefficient of the node load Q-P ratio

Eq. (12) shows that in non-illumination time intervals, the node load Q-P ratio has an approximate relationship with the node's active load. β_{oi} is the node load Q-P ratio in the early peak time interval; (P'early peak$_i$ – P_{ij}) calculates the impact on the node load Q-P ratio with the changes in number of asynchronous dynamos in operation; the coefficient ai is determined statistically.

The node load Q-P ratio of the evening illumination time intervals can be used as an approximate substitute for the late peak node Q-P ratio.

IV. Using the Improved Vector Smoothing Method To Forecast Node Active Load

In the provincial and regional power network dispatch center, the node active load data for the three time intervals of early peak, late peak, and valley and data on 24 time interval node active load of some important nodes is very complete. It is useful for improving the precision of node load pattern forecasting of node active load for the 3 time intervals of early peak, late peak, and valley, and 24 time interval node load forecasting for important nodes has important significance for economical and safe computations for electric power systems.

1. Multidimensional forecasting vector pattern

Document [4] introduces a vector smoothing pattern.

Defining S as the smoothing operator and X_t as the random vector

$$S(X_t) = a^T \cdot X_t + (I - a)^T \cdot S(X_{t-1}) \tag{13}$$

in which α is the smoothing factor vector, α_i is any component satisfying

$$0 < a_i < 1,$$

I is the unit vector

making the smoothing value $S(X_t)$ of t time X_t as the forecast value
of t+1 time

when t=1, Eq. (13) is

$$S(X_1) = a^T \cdot X_1 + (I - a)^T \cdot S(X_0) \tag{14}$$

When starting forecasting, $S(X_0)$ is not known, thus adopting the vector smoothing method in the initial stages can cause problems. This paper used the following method to overcome these difficulties.

Let $S(X_0) = \mu$

is the estimate value of the vector of the average value of X_t, then with (14) we have

$$S(X_1) = a^T \cdot X_1 + (I - a)^T \cdot \mu \tag{15}$$

When applying (13) for forecasting, in the early stages, since we have only obtained a few historical samples of vector values, we discovered that selection a large $||\alpha||$ was beneficial, since if $||\alpha||$ is larger, then immediately the weight of the sample vector will be larger and this reduces the deviation caused by setting $||S(X_0)||$ too high or too low when beginning forecasting.

The smoothing factor vector a is used to increase the weight of loads from the past, and from Eq. (13) for the i'th component of X_t we have

$$S(x_{t,i}) = a_i x_{t,i} + (1 - a_i) \cdot S(x_{t-1,i})$$
$$= a_i \sum_{j=1}^{t-1} (1 - a_i)^j x_{t-j,i} + (1 - a_i) S(x_{0,i})$$

Since $a \in (0,1)$, as the sample gets out of date, the added weight gradually decreases, thus it is not hard to see the impact of the comprehensive past historical sample value $S(X_{t-1})$ on $S(X_t)$, and if all past historical information is compressed into one body, it has a different weight on the past historical sample values.

2. Revised multidimensional vector forecast pattern

At present, the node load data for the electric power system is small and it is impossible to promptly master all the data from node loads, thus when using Eq. (13), it had to be revised.

Supposing P is the probability vector of the total load of the system occupied by node load

$$P = (P_1, P^2, \ldots, P_n) \tag{16}$$

in which n is the number of nodes

(16) satisfies the pooled normalized equation

$$P \cdot I^T = 1 \tag{17}$$

If the data for k nodes at t time interval and the overall system active power load of t time interval* [*time interval here refers to day] after deducting network loss is known, then

$$\bar{P}_{it} = P_{NLit}/P_{SLt} \tag{18}$$

in which iεk

P_{NLit} is the node active power load of i node at t time interval

If j$\bar{\varepsilon}$k, then since P_{NLjt} is not known, P_{jt} cannot be found using Eq. (18). Here, we assume that if P_{jt-1} and that P_{jt-1} and that P_{jt-1} is known, then the probable values of the nodes at t time interval can be approximated. However, the P not obtained does not satisfy the pooled normalized equation (17), thus, pooled normalization processing must be carried out on $\bar{P}$.

$$\tilde{P}_{it} = \bar{P}_{it} / \sum_{j=1} \bar{P}_{it} \tag{19}$$

Thus we obtained the approximate probable vector $\hat{P}_t$. By solving (13) we can obtain the smoothing value of the node load probable vector at t+1 time interval $S(\hat{P}_{it})$.

From the overall load forecast method introduced in this paper, the overall system load forecasting value can be obtained and after deducting network loss, we obtain $\hat{P}_{SLt}$, and substituting this in (20)

$$S(P_{NLt}) = \hat{P}_{SLt} \, S(\hat{P}_t) \tag{20}$$

$S(P_{NLt})$ can be the node load forecast of t+1 time interval.

V. Setting Up the Node Load Pattern

1. Node active load pattern

Most node active loads and overall active load have similar changes, and when the node load data is scarce, the node active load pattern can be approximated using this characteristic.

Suppose the overall active load early peak-valley difference is

$$DP_m = P_{\text{early peak}} - P_{\text{valley}} \qquad (21)$$

the difference between the overall active load non-peak time and valley is

$$DP_i = P_i - P_{\text{valley}} \qquad (22)$$

Then the yangqi [2254 6386] coefficient of the overall active power load at any time interval

$$a_i \equiv \frac{DP_i}{DP_m} \qquad (23)$$

Thus, the overall active power load of each time interval is

$$P_i = P_{\text{valley}} + \alpha_i \cdot DP_m \qquad (24)$$

Taking into account the fact that node active power load and overall active power load have similar changes, the time interval load yangqi coefficient can be used for each node. For the j'th node's active power load, the early peak-valley difference is

$$DP_{mj} = P_{\text{early peak}} - P_{\text{valley}} \qquad (25)$$

The node active power load at other time intervals can be expressed as

$$P_{ij} = P_{\text{valley } j} + \cdot DP_{mj} \qquad (26)$$

For illumination time intervals which have their own special node load patterns, the node active load pattern of Eq. (26) must be corrected.

Supposing the node late peak load obtained by Eq. (26) was P'_{Wj}, and the node late peak load obtained by the revised vector smoothing method was P_{Wj}, then

$$\Delta P_{Wj} = P_{Wj} - P'_{Wj} \qquad (27)$$

Therefore, in illumination time intervals, the node active load obtained by (26) must go through the following correction

$$P_{ij} = P'_{ij} + \Delta P_{Wj} \qquad (28)$$

in which iε illumination time interval

2. Pooled Normalization of Node Active Load Pattern

The node active load pattern obtained by the above method is preliminary, and will not necessarily satisfy pooled normalization conditions between node

active load and overall active load for each time interval, thus it is necessary to correct it.

Supposing the node active load obtained by the above method is P_{ij}, then we have the following pooled normalization equation

$$\theta_{ij} = P_{ij} / \sum_{j=1}^{n} P_{ij} \qquad (29)$$

in which n is the total number of nodes.

If the overall system load forecast after deducting network losses is P_{SLi}, then the node active load is

$$\tilde{P}_{ij} = P_{SLi} \cdot \theta_{ij} \qquad (30)$$

Thus we obtain the node active load pattern.

3. Node Idle Load Pattern

After obtaining the node active load pattern, from the node load Q-P ratio, one can easily obtain the node idle load pattern

$$Q_{ij} = \beta_{ji} \cdot P_{ij} \qquad (31)$$

in which j is the number of time intervals

       i is the node number

Conclusion

1. Although there is a great deal of randomness in the node load and historical load data is scarce, there are still clear physical characteristics and proceeding from node load physical characteristics, it is possible to forecast the node load pattern.

2. Multidimensional node load pattern forecasting depends on overall load forecasting: the two are fused into one entity. The statistical method can be used for forecasting node load where the node load is important and data is complete, the node load forecast and the node load pattern forecast are complementary and consider the speed and accuracy of the forecast.

3. Using the computer node load pattern forecast clearly reduces the time compared to the manual handling of node load data. Furthermore, revision is easy and it is easy to use and it creates conditions for use of optimum current flow and safety analysis applications software.

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TITLE: "High Performance Size Exclusion Chromatography for the Separation
of Proteins on Sinopak-EGPM"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 13 No 3,
20 Mar 85 pp 164-167

TEXT OF ENGLISH ABSTRACT: Porous microspheres of an acrylate polymer (EGPM)
have been used as column packing for size exclusion chromatography of some
proteins. The gel can withstand a pressure drop of 200-300 kg/cm^2, with a
column efficiency of 400-800 theoretical plates/m. The sample linear capacity
is about 100 μg muramidase/g of EGPM. The molecular weight-elution volume
calibration curve shows that it can be used to separate proteins of molecular
weights below 6 x 10^4 (in approximately 10 minutes) on a φ4.6 mm x 0.5 m
column. Detection of impurities in some proteins is illustrated. (Paper
received on 26 December 1983.)

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TITLE: "Alternative Oscillopolarographic Titration of Zirconium in Monomineral of Zircon"

TEXT OF ENGLISH ABSTRACT: A simple, rapid and accurate method has been proposed for the oscillopolarographic titration of zirconium in the zircon monomineral. A standard EDTA solution in excess is added to complex the Zr(IV) ions in a slightly acidic acetate solution (pH=6), followed by back titration of the residue amount of the standard EDTA with a standard Pb(II) solution, using the appearance of the Pb incision to indicate the end point. Interferences from Al(III), Fe(III) and Ti(IV) are eliminated by adding tiron and malonic acid. The end point is sharp and is not interfered with in the presence of precipitates or colored substances. (Paper received on 13 December 1983.)

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TITLE: "Preparation and Application of Chelating Resin. II. Its Separating
Performance for Microamounts of Rare Earth Elements"

TEXT OF ENGLISH ABSTRACT: AsI chelating resin with the characteristic
construction of arsenazo I is used to examine the separating performance.
The parameters of resin exchange capacity and partition coefficient separating
factor for some rare earth elements have been obtained. α-Hydroxyisobutyrate
of different acidities and concentrations is adopted to separate the rare
earths on a column. The Lu-Nd-La ions are eluted and separated quantitatively
within 2.6 hours, with total volume of elution being 78 ml. The recovery
rate for rare earths is 96.7-102.5 percent. (Paper received on 12 March 1984.)

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QU of the Laboratory, Anhui Geological Bureau

TITLE: "A Study of Dual-Wavelength Sepctrophotometry--Simultaneous Determination of Tungsten and Molybdenum"

TEXT OF ENGLISH ABSTRACT: A dual-wavelength spectrophotometry method which employs a computer to select the optimum wavelength pairs is proposed for simultaneous quantitative determination of trace tungsten and molybdenum in ores using Na_2O_2 to melt the sample and color complexes of W-salicyfluorone-cetyltrimethyl and Mo-salicyfluorone-cetyltrimethyl in 0.6N HCl. The measuring wavelength and referential wavelength are 514 nm and 530 nm for W, 526 nm and 510 nm for Mo. The calibration curves are linear in the range of 0 to 20 μg/25 ml for W, and 0 to 6 μg/25 ml for Mo. The standard deviations and relative standard deviations are 0.001 percent and 0.01 respectively for WO , 0.002 percent and 0.06 for Mo. (Paper received on 30 December 1983.)

AUTHOR: WANG Yongxian [3076 0516 0341]
          QIN Junfa [4440 0193 3127]
          WU Shiming [0702 1102 2494]
          et al.

ORG: Shanghai Institute of Nuclear Research, Chinese Academy of Sciences

TITLE: "Investigation of the Loss of Trace Elements in Biological Materials in Different Drying and Ashing Procedures Using Radioactive Tracers. I. Zn, Mo, Cd and Se"

TEXT OF ENGLISH ABSTRACT: Using radioactive tracers it is found that freezing dry is safe for Zn, Mo, Cd and Se in all matrices studied. Oven dry is also safe except for Se in hair. The oxygen plasma ashing does not cause any loss of Zn, Mo and Cd. Different degrees of loss were observed in oven ashing with the exception of Zn and Mo in hair and shallot. It is obvious that the loss rate of the trace elements depends on their chemical forms present in the matrices. The retention of the four elements studied on the wall of a quartz container can be neglected after oxygen plasma ashing. However, Zn, Cd and Mo were retained to various degrees after oven ashing. (Paper received on 3 January 1984.)

AUTHOR: LIU Yuru [0491 3768 5423]
          CHEN Mingde [7115 2494 1795]
          LI Chongying [2621 1504 5391]

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TITLE: "Studies of a New Color-Forming System. II. The System Ag(I)-5-(3,5-Dichloro-2-Pyridylazo)-2,4-Diaminotoluene-Sodium Dodecylbenzene Sulfonate-Triton X-200"

TEXT OF ENGLISH ABSTRACT: The optimum conditions for the color reaction of Ag(I)-3,5-Cl_2-PADAT-SDBS-Triton X-200 have been studied systematically. In a citrate buffer solution of pH 3.5 to 4.5, Ag(I) forms a red quaternary complex with 3,5-Cl_2-PADAT in the presence of SDBS and Triton X-200. The maximum absorption of the complex is at 490 nm, and its apparent molar absorptivity is 5.4×10^4 $1 \cdot mol^{-1} \cdot cm^{-1}$. The ratio of Ag(I) to 3,5-Cl_2-PADAT to SDBS has been established to be 1:4:4. Beer's law is obeyed in the range of 2.5 to 25 µg/25 ml. Interference from Fe^{3+}, Al^{3+}, Pd^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, etc., can be eliminated by using CyDTA as the masking agent. The method has been applied to the spectrophotometric determination of silver in ores. (Paper received on 3 January 1984.)

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         LI Xingmin [2621 5281 3046]
         JIN Yingtai [6855 7751 3141]

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "A Useful Analytical Technique of Infrared and Laser Raman Spectra"

TEXT OF ENGLISH ABSTRACT: In this paper we present a new method to analyze
organometallic compounds sensitive to trace oxygen and moisture by infrared
and laser Raman spectra. The experimental results indicate that the method
is reliable and easy to operate. (Paper received on 27 October 1983.)

9717
CSO: 4009/1079

AUTHOR: WANG Youtong [3769 0645 2717]

ORG: Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou

TITLE: "Structural Analyses Based on a Point Charge Model"*

TEXT OF ENGLISH ABSTRACT: The point charge model in Mossbauer nuclear quadrupole splitting is very convenient for calculating the quadrupole splitting since its values are in good agreement with the experimental results. By using this model, fast and effective semi-empirical analyses can be carried out on the structure and bond characteristics of quite a number of compounds of Mossbauer atoms possessing a certain symmetry.

In this paper, expressions of the point charge models for 28 structural configurations are presented. In addition, the quadrupole splittings of some compounds of iron and tin have been calculated and their isomers, coordination numbers and configurations as well as configuration distortion are discussed.

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TITLE: "A Study of the Purification of Rh by Extraction with P₅₃₈ from
Mixtures Containing Pt, Pd, Rh and Ir"*

TEXT OF ENGLISH ABSTRACT: A solvent extraction process for the purification
of Rh from mixtures containing Pt, Pd, Rh and Ir has been developed.   The
mixtures were first boiled with HCl to convert polynuclear complexes to
monomeric.   Ir(IV) was reduced to It(III) with hydroquinone after cooling.
The pH was brought to 11-12 with NaOH.   The solutions were maintained at this
pH at 35°C for 30 minutes, and then acidified to pH 1.2-1.5 with HCl.
Chlorine was passed through the solutions to restore Ir(III) to Ir(IV).   The
hydrated cationic Rh(III) species thus prepared were extracted to partially
saponified P₅₃₈ (a mixture of monoalkyl phosphates)-HDEHP-kerosene solutions
in a volume ratio of 2:5:15, while Pt, Pd and Ir were left in the aqueous
phases as complex anionic species.   Rh(III) was finally back-extracted with
1-6M HCl.   The experimental results showed that the direct recovery of Rh
was higher than 95 percent and the amounts of Pt, Pd and Ir extracted were
less than 1 percent for a single-stage extraction.

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TITLE: "Studies on Thermal Stabilities of Coordination Compounds by Gas Chromatography. IX. Thermal Decomposition of $Fe_2(C_2O_4)_3$-HZSM-5 and $Fe_2(C_2O_4)_3$-HY"*

TEXT OF ENGLISH ABSTRACT: Some properties and thermal decomposition of Fe(III) oxalate supported on HZSM-5 and HY zeolites have bee studied by GC, IR and Mossbauer spectral methods. According to the results of the GC experiments, thermal decomposition of the unsupported Fe(III) oxalate took place in two steps as indicated by peak α, giving CO_2, and peak γ, yielding CO and CO_2, but Fe(III) oxalate supported on zeolites gave additional peak β, producing CO and CO_2, as a result of the interaction between $C_2O_4^{2-}$ and Al^{3+}.

The Mossbauer parameters of $Fe_2(C_2O_4)_3$-HZSM-5 system were similar to those of $Fe_2(C_2O_4)_3 \cdot 5H_2O$, indicating that the effect of HZSM-5 was fairly weak. However, the spectrum of $Fe_2(C_2O_4)_3$-HY consisted of two doublets, with one having a smaller Δ and the other a larger Δ. For part of Fe(III), there could be no direct interaction between the metal and the support giving a smaller Δ, but for the other part of Fe(III), the larger Δ might be due to the coordination of Fe(III) on the surface of the support during impregnation.

At 240°C most of the Fe(III) of $Fe_2(C_2O_4)_3$-HZSM-5 was reduced, yielding CO_2 and FeC_2O_4. However, for $Fe_2(C_2O_4)_3$-HY, as much as 64 percent of Fe(III) could not be reduced at the same temperature. At 500°C $Fe_2(C_2O_4)_3$-HZSM-5 produced α-Fe in hydrogen, but for $Fe_2(C_2O_4)_3$-HY, the decomposition products consisted of surface Fe(III) and Fe(II) oxides, α-Fe and highly dispersed Fe(0). This confirmed the fact that the interaction between iron cations and the surface of HY zeolite led to dispersion of the decomposition products on the support and made part of the iron cations more difficult to be reduced.

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TITLE: "The Studies of the Nature of Chemisorption Bond Using Low Energy Ion Beam: N$^+$-CO/Ni(100), CO/Cu(100)"*

TEXT OF ENGLISH ABSTRACT: The ion-neutralization and ion-molecule reactions of N$^+$ with CO molecules adsorbed on Ni(100) and Cu(100) have been studied at the ion energy of 10eV. In the N$^+$-CO/Ni(100) system, no product ion was observed and only ion neutralization occurred. In the N$^+$-CO/Cu(100) system, O$^+$ and CO$^+$ were detected and the ion-neutralization cross section was smaller than that in N$^+$-CO/Ni(100). The difference in the ion-neutralization cross section is explained by the difference of the chemisorption bond nature of the CO molecule with metal atoms, i.e., the amount of back donation of metal d electron into the vacant antibonding 2π* orbital on the CO molecule. This explanation is supported by the observation of the N$^+$ collision with CO/K/Cu(100).

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TITLE: "Studies of Preparation, Structure and Electrical Properties of
the Complex Oxide $Sm_3Ti_2O_7$"*

TEXT OF ENGLISH ABSTRACT: A new complex oxide, $Sm_3Ti_2O_7$, containing one
bivalent and two trivalent samarium ions in the molecule, is prepared by the
reduction of Sm_2O_3 and TiO_2 with metallic Sm at a high temperature.   Its
structure and electrical properties were studied.   The compound $Sm_3Ti_2O_7$
belongs to the monoclinic system.   Its cell dimensions are a=3.969, b=3.907,
c=20.460Å; β=89.20°.   Its electrical resistivity ρ is 7.4 Ω·cm.   It changes
from a p type semiconductor into a n type semiconductor at 240°C.   The valence
state of samarium and titanium in the compound is discussed according to its
structure, electrical properties and band structure.

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TITLE: "The Molecular Structure and Crystal Structure of Tungstyl-
Bisbenzohydroxamage Chelate Compound"*

TEXT OF ENGLISH ABSTRACT: The crystal structure of $(C_7H_6O_2N)_2WO_2$ was
determined on a Syntex-R3 four-circle diffractometer with X-ray intensity
data collected in a $\theta-2\theta$ scanning mode. The space group is $C_6^2-P6_1$, with
a=17.38(2), c=10.872(8)Å, Z=6. The position of the tungsten atom was
revealed by the Patterson function and direct method. Then the parameters
of the remaining non-H atoms were determined from Fourier and different Fourier
syntheses. Refinement was carried out by the block-diagonal matrix least-
squares procedure. The structure was refined to a final R value of 0.0558.

The investigation confirms that W(VI) is coordinated in a distorted octahedron
by six oxygen. The chelate rings surrounding W(VI) are planar five-member
rings. The lengths of the C-C bonds connecting the chelate rings and their
respective benzene rings are shorter than normal C-C bonds. The angles
between these two planar rings are not large. It is possible that some of
the π electrons in these two conjugated systems are able to overlap each
other.

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TITLE: "A Microcomputer Controlled System of an Atomic Absorption
          Spectrophotometer"

SOURCE: Changchun FENXI HUAXUE [ANALYTICAL CHEMISTRY] in Chinese Vol 12 No 12,
          20 Dec 84 pp 1106-1109

ABSTRACT: In recent years, an important development trend in analytical
chemistry has been general application of microcomputers in data processing and
automatic control of analytical instruments. Abroad, some analytical instrument-
making companies built the so-called computer-aided chemistry equipment; controlled
by a computer, the analytical results can be instantaneously obtained, not the
long time period required in the past for analytical chemists. Thus, much man-
power and materials are saved. At present atomic absorption spectrophotometers
have been generally used in China's analytical laboratories, becoming an
important means of elemental analysis. Therefore, a major subject for instrument
personnel and analytical chemists is how to apply microcomputer techniques for
the development and improvement of atomic absorption spectrophotometers.

An air-acetylene torch was used to analyze the standard samples provided by the
Shanghai Reagent Research Institute. The standard sample is Cu 101.0 ppm; the
instrumental analysis results are Cu 103.0, 102.8, 101.6 and 100.0 (for a total
of four continuous tests). The average value is 100.3 ppm and the relative
standard deviation is 0.7 percent. As analyzed with a graphite furnace on a Cr
sample provided by the Geography Institute, Chinese Academy of Sciences, by using
the peak reading method for 11 continuous replications of extinction value deter-
mination, the values are 0.218, 0.212, 0.217, 0.218, 0.216, 0.212, 0.216, 0.216,
0.209, 0.213 and 0.208. The absolute sensitivity is 0.5×10^{-11} gram; the rela-
tive standard deviation is 1.6 percent. In China this is just a beginning for
microcomputer-controlled chemical analysis with an atomic absorption spectro-
photometer. Many technical problems still await development. The following
statement should be stressed: microcomputer-controlled chemical analysis
requires effective cooperation between instrument-making research units and
analytical chemists. Through the common effort of the two, the AAS (atomic
absorption spectrophotometer) microcomputer system with Chinese features
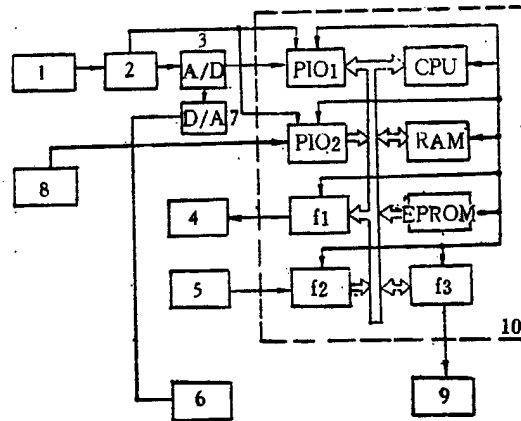patronized by users can be developed.

Fig. 1   AAS Microcomputer System

Key:

1. Photoelectric multiplier
2. Demodulator and modulator
3. A/D and logarithmic converter
4. Display device
5. Input keyboard

6. Recording instrument-meter
7. D/A converter
8. Graphite furnace power source
9. Microprinter
10. Microcomputer
    f1. Display interface
    f2. Keyboard interface
    f3. Printing interface

The microcomputer consists of a Z80 CPU, 2 K RAM, and 8 K EPROM. This AAS system has some advantages over conventional AAS: the sampling rate for analytical data is four times faster, and the microprinter has plotting capability and auto-scaling, which are especially important for graphite furnace analysis. Another figure in the paper shows a block diagram for the AAS program. The paper was received for publication on 3 January 1984.

10424
CSO: 4009/1078

Computer Development and Applications

AUTHOR: LIU Hong [2692 3163]
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TITLE: "Originating an Interactive Graphics System for Microcomputers"

ABSTRACT: The interactive computer graphics system is the foundation of CAD
(computer aided design); however, there is no made-in-China computer graphics
system commercially available. The authors have completed an interactive
graphics system for supporting CAD on the PDP-11/03 microcomputer. This paper
discusses the system's development, the first part of the authors' work. The
paper presents the system configuration and operation. The developed system
has a high performance-to-price ratio and universality; the concept of ideal
graphics plotter makes it easier to develop and interchange graphics software,
as well as equipment upgrading. This is helpful to CAD applications in China.

Currently, only two-dimensional graphics can be plotted. The output bit rate
is 9,600. Eight figures show system-oriented peripheral equipment, connections
between a V550 graphic terminal and the CPU, between the plotter and the CPU, and
between the digitizer and the CPU, flowcharts of the graphics display processor,
hard copy processor, and output processor, and arrangement of a fluorescent
screen and digitizer. The authors thank instructor Kang Xingwu [1660 5281 7005]
for his assistance.

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TITLE: "Microcomputer Compiling and Typesetting System in Chinese and English"

ABSTRACT: The paper introduces a microcomputer (64K RAM) compiling and type-setting system in Chinese and English, suitable for information service units. The Chinese character display device uses a dot-matrix array of 14 x 14, capable of showing 7,483 characters. The maximum capacity of the read-only memory is 384K, and at most four floppy disks can be interfaced. The output rate is 35 Chinese characters per second, or 105 English letters per second. Major techniques are introduced, such as automatically setting up of indexes and files, as well as compiling and printing-typesetting. Concepts for improving the system are outlined. Two figures show a 16-mo double-column page format, and a sample page of compiled typesetting. The author expresses his gratitude to Zhang Wei [1728 5524], Ouyang Jiming [2962 7122 4949 2494], Shan Qicheng [0830 0796 2052] and Xie Qi [6200 3825] for their support.

10424
CSO: 4009/1081

Engineering

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TITLE: "Program Presetting Digital Modulator and Demodulator"

SOURCE: Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in
         Chinese Vol 15 No 4, 10 Apr 85 pp 7-8

ABSTRACT: The 8253 timer is the central unit of the programmable presetting
digital modulator and demodulator. The 8080 or 8085 microcomputer digital
communications system is the object of application. The operating frequency
can conveniently vary with the program. A simple digital modulator and demodu-
lator consist of one 8253 circuit board, three D flipflops and two AND/NOT
gates as shown in one of four figures in the paper. The circuit of the
programmable presetting demodulator occupies a small area with flexible applica-
tions; a self-measurement circuit can be conveniently constructed. Positioning
can be carried out if there are malfunctions by self-checking. Three remaining
figures show a demodulation circuit, division of the time window ("0" and "1"
windows), and operational time sequence. Two tables list data of presetting
values and errors.

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Engineering

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TITLE: "Tuning Fork Photo-chopper and Its Applications"

SOURCE: Beijing DIANZI KEXUE JISHU [ELECTRONIC SCIENCE AND TECHNOLOGY] in Chinese
          Vol 15 No 4, 10 Apr 85 pp 22, 6

ABSTRACT: The tuning fork photo-chopper is made based on the form of a tuning
fork, its operating principle, and oscillation mode. Some parts are added to
assemble the photo-chopper, which can be considered as a derivation of the
tuning fork. Besides the light modulation as the function of an optical device,
the photo-chopper still retains the tuning work feature. As for aspects of
photo-chopper manufacture, available commercially are equipment for 40 Hz through
100 Hz, especially 100 Hz through 1500 Hz. If allowed by circuit design or
frequency, the selection of photo-choppers can be made in the range of 100 Hz
through 1500 Hz. For rapid initiating oscillation, photo-choppers operating
above 800 Hz can be used. The composite-type structure is sound. If only the
area width of photo-chopping is emphasized, selection should be made for
equipment operating below 500 Hz. If two oscillation signals are required, it
is suggested to select photo-choppers with circuit configuration. In short,
operating economy and feasibility should be simultaneously considered in
selecting tuning-fork type photo-choppers. One table lists data showing main
technical considerations. Three figures show fork-shaped structures, oscillat-
ing circuits, and application of the tuning-fork photo-chopper.

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ABSTRACT: The paper describes a JY4795 type intelligent actinometer with a micro-
computer; its features include automatic calibration by computation with a CPU,
software used to substitute for hardware if possible, and simultaneous measure-
ments of five radiation intensities, instantaneous value, maximum value, 24-hour
cumulative value, hourly cumulative value, 24-hour total daylight time, and hourly
daylight time. A microprinter is installed in the actinometer for data printing
at preset time, or printing of partial or all data on user demand. In addition,
the start and stop of measurement time instants are recorded. Ten figures show
a system block diagram, flowcharts of the main program, program start, keyboard
display, and CTC1 (and CTC3) interruptive service subroutine, connection of CTC
channels, line connection of data measurement, time sequence of selective signals,
and equivalent circuit of the input terminal. One table shows polarity markings
of measured voltage, measurements and others.

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TITLE: "Effect of Nitrogen Oxide (NO) on Laser-Induced Chemical Reaction
           of F_{12}"

ABSTRACT: The effect of NO on the laser-induced chemical reaction of F_{12}
(CF_2Cl_2) is studied; the laser used is a continuous-wave CO_2 laser. Analyzed
with the infrared spectrum method and gas phase color spectrum method, the main
reaction products are F_{13}, F_{114}, NOCl and CF_2O. The dissociation yield of
F_{12} (in F_{12}+NO mixture) increases with the increasing NO partial pressure,
reaches a maximum and then drops off. The reaction regime is discussed.

The maximum output of the laser is 20 W; the output power can be adjusted with
the operating voltage. The system pressure can be measured with an indicator.
Four figures show the experiment set-up, the infrared spectra before and after
F_{12}+NO reaction, the relationship between NO content and F_{13} and F_{14} fractions
as dissociated from F_{12}+NO, and the energy threshold value for laser decomposi-
tion of F_{12}+NO. Two tables list data showing infrared vibrational frequencies
of NOCl and the relationship of three factors: F_{12}+NO dissociation fractions,
incident laser power, and partial pressure of F_{12}.

10424
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ORG: Huadong Engineering College

TITLE: "Continuous-Wave CO_2 Laser-Induced Reaction for Synthesizing Methylamine"

ABSTRACT: The paper presents a preliminary investigation of applying a laser to basic reactions of organic synthesis; a continuous-wave (CW) CO_2 laser of about 10 watts is used to induce the synthesis of methylamine. In the initial stage, tens of milligrams of methylamine chloride were obtained at room temperature (below 100°C) and low pressure (less than 1 atmosphere) without the use of a catalyst. Since the synthesis of methylamine using ammonia and methyl alcohol is among the major reactions in industrial organic chemistry, a laser not only can considerably moderate the reaction conditions, but also can have a highly selective reaction with the only product being monomethylamine. Currently, the power of the CW CO_2 laser reaches the level of 10,000 watts, a good prospect of laser application in the chemical industry is a certainty if the potentialities of the laser can be sufficiently exploited. Three figures show the experiment set-up, infrared spectrum, and nuclear-magnetic-resonance hydrogen spectrum of the reaction products. The authors express their gratitude to Ji Faxiang [0679 3127 4382], Wang Naiyan [3769 0035 1484] and Yang Xujie [2799 4872 2638] for their assistance in instrumental analysis. The paper was received for publication on 3 October 1984.

AUTHOR: ZHENG Qiguang [6774 0796 0342]
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TITLE: "Experimental Research on Laser Welding With a High-Power Continuous-Wave
          CO_2 Laser"

ABSTRACT: Since the development of 1,000-watt level continuous wave (CW) CO_2
lasers in 1970, the welding capability of lasers has been significantly enhanced.
The high-power CO_2 laser is used in deep penetrating welding. In this paper
the characteristics and regime of laser welding with high power (1 to 2 kW)
CW CO_2 laser are described; the weld processes and parameters of deep-penetrating
laser welding were also discussed. Using a 2 kW multi-mode beam and 2.5 kW TEM_{oo}
mode beam for, respectively, low alloy steel and No 45 steel, the experimental
data and a cross-sectional micrograph of the weld area were presented. The
relationship curves for welding penetration depth, laser power and scanning rate
are shown in 5 of the 12 figures. Owing to long optical path of the lightguide
system in the authors' experiment, the loss of beam energy is about 30 percent.
The use of concave mirrors causes greater beam distortion, affecting laser welding
results to a certain extent. The seven remaining figures show different types of
CO_2 lasers, characteristics of deep-penetrating laser welding, multi-mode TEM_{mn}
and single-mode TEM_{oo}, butt-welding photographs of low-alloy steel plates, laser
lap-welding photograph, and photographs of metallurgical texture of low-alloy
steel and No 45 improvable steel with laser welding. Four tables list data of
laser welding parameters of low-alloy steel and No 45 improvable steel. The
authors express their gratitude to Cheng Zuhai [4453 4371 3189], Li Jiagu
[2621 1367 6253] and Liu Donghua [0491 2639 5478] for their taking part in
experiments. The paper was received for publication on 8 September 1984.

Mathematics

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TITLE: "Eigenvalue Analysis of the Condition for Robust Stability of Control Systems--Comments on the Paper, 'Perturbation in Characteristic Value and Stability of Control System'"

ABSTRACT: The paper "Perturbation in Characteristic Value and Stability of Control System" by Sun Jing [1327 7234] was published in this journal, No 3, 1984. The author points out that two of the three conclusions in Sun's paper are incorrect because the two special matrix norms applied do not meet two pre-determined conditions. Therefore, the calculation of the optimization limit of the perturbation matrix is wrong. The limit is relatively crude for the perturbation matrix in Theorem 1; some improvements are feasible using matrix theory. By application of Gerschgorin's disk theorem on eigenvalue analysis to the perturbation matrix of control system, an improvement of the boundedness for the robust stability of the system is given. The paper was received for publication on 22 September 1984.

10424
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TITLE: "Weierstrass Formula and Its Applications"

ABSTRACT: This paper discusses the Weierstrass formula and its applications. The symmetricity of minimum surfaces in three-dimensional Euclidean space is discussed with application of the classical Weierstrass formula. The generalized Weierstrass formula is then discussed; the discussion is applied to an analysis of the rotational surfaces of constant mean curvature. In this paper, the author has solved the following problems: 1) He has proved Theorems 1-5, thereby solving the tricky problem whether there exist symmetric lines or symmetric planes on minimal surfaces. Some important minimal surfaces are discussed. 2) The author has proved Theorem 6, thus bringing the generalized Weierstrass formula and the classical Weierstrass formula into a unified whole. 3) The author has proved by Theorem 7 that a generalized Weierstrass formula can lead to the derivation of a unified equation for all rotational surfaces of R^3 with a constant mean curvature. The author expresses his thanks to teacher Peng Jiagui [1756 1367 6311] for his guidance, and to teacher Zhang Jingzhong [1728 2529 0022] for his advice. The paper was received for publication on 24 May 1984.

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TITLE: "Growing Large Single Crystals of Protein Using a Vapor Diffusion
         Method With Hanging Drop and Repeated Seeding Technique"

ABSTRACT: Up to now the literature has not included any report in China on the
growing of large single crystals of protein using the hanging drop vapor diffusion
method with the repeated seeding technique. However, this paper reports on the
growing of complex crystals of trypsin (from porcine pancreas)--trypsin (from
green lentil) inhibitor with approximate dimensions of 1.5 x 0.7 x 0.7 mm from
hanging drops of only 68 micrograms of protein by using the hanging drop vapor
diffusion method. In another experiment, first the authors grew small crystals
of complex specimens I and II of chymotrypsin (from porcine pancreas)--trypsin.
Large crystals were anticipated by changing concentrations, types of precipitant,
pH and temperature factors of constituents, as well as hundreds of screenings for
crystallization conditions. The effort failed. Success was attained eventually
by using the repeated seeding technique of crystals, obtaining large crystals of
the two above-mentioned specimens with dimensions of 1.0 x 0.7 x 0.5 mm and
1.1 x 0.6 x 0.6 mm, respectively. Determinations were made on cell parameters
and space group.

Five figures show the hanging drop type vapor diffusion method, a photograph of
amplified crystals of trypsin (from porcine pancreas)--trypsin (from green lentil)
inhibitor complex, and photographs of amplified crystals of complex samples
I and II of chymotrypsin (from porcine pancreas)--trypsin.

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Physics

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TITLE: "Automatic, Rapid UHV Ionization Vacuum Gauge"

ABSTRACT: This type of vacuum gauge utilizes the linear relationship between ion current and gas pressure in a hot cathode ionization gauge when electric current is emitted. A series of technical problems remains to be solved, such as the remote automatic rapid determination of weak ionization current, long distance power supply of filament, and suppression of interfering signals. The automatic, rapid wide-measurement-range ionization vacuum gauge was designed and constructed by the authors' institute with low-priced, conventional (made in China) elements and devices; this vacuum gauge can be adapted to almost all ultrahigh vacuum B-A ionization gauges available commercially. The vacuum gauge is a combination of an automatic electrometer and A.C. switch type stabilized electron current emitter; suitable to the sensitivity level $S = 5 \sim 30$ torr^{-1}, the hot cathode ionization gauge is highly adaptable to filaments. In addition, long-distance heating and control are feasible for the ionization gauge, performing linear automatic rapid remote sensing of wide-range vacuums. As for plasma research, of interest is the gas density n (number of molecules per cm^3) of the residual gas in vacuum reaction chamber. It is best to have density read using the vacuum gauge. An equation is given to express the relationship between gas density n and pressure P. References for this study include the following: 1) Chen Fangjun et al., ZHENKONG [VACUUM], 2, 11 (1983); 2) R. Chapman, REV. SCI. INSTRUM., 37, 1748 (1966); 3) Wu Sicheng [0702 1835 6134] et al., ZHENKONG JISHU [VACUUM TECHNOLOGY], 2, 28 (1979); and 4) Chen Fangjun et al., HEJUBIAN YU DENGLIZI WULI [NUCLEAR FUSION AND PLASMA PHYSICS], 1, 60 (1984). Two more figures show a current versus voltage conversion circuit and an automatic electrometer. One table lists data showing the relationship between input current and automatic conversion of the measurement range. The authors express their gratitude to Yu Shuyong [0060 2579 3057], Wang Shoushe [3769 1108 6080], Yang Wenbo [2799 2429 0590], Yang Zuogui [2799 0155 6311] and Dong Yuying [5516 3768 5391] for many of their assistances.

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