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1 DECEMBER 1986

EUROPE REPORT

SCIENCE AND TECHNOLOGY

WEST EUROPE

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SWEDISH MASSPECTROMETER, MICROPROCESSOR IN USSR PHOBOS PROJECT

Masspectrometer Described

Stockholm NY TEKNIK in Swedish 16 Oct 86 pp 42-43

[Article by Hans Werner: "Skimming Over Mars' Moon"]

[Text] At midsummer 1988, Operation Aspera will start towards the planet Mars and its moon, Phobos. It is a Swedish plasma experiment on board Soviet space probes which for 15 minutes will travel across the surface of Phobos at an altitude of about 50 meters.

After orbiting the planet for 200 days, the space probe will skim over the moon Phobos at an altitude of 50 m and will land two moonlanders. At the same time, the instrument, which was built in Kiruna, will be analyzing the composition of the surface of Phobos on board the probe.

Aspera stands for "Automatic Space Plasma Experiment with a Rotating Analyzer System." It is an experiment for the study of the solar wind and its interaction with Mars and Phobos (from the Latin word for "fear").

The cooperation between the Kiruna Geophysic Institute and the Soviet space scientists goes back to a treaty in 1976. The Swedish scientists have participated with instruments in several Soviet space experiments.

Swedish Instruments

In reality the cooperation started in 1977, and in 1978 the Swedes took measurements with a masspectrometer in the outer magnetosphere around our own planet. That occurred on board the Soviet satellite Prognos 7.

On Christmas Day 1980, a similar experiment was carried out on board Promex 2, which, according to plans, will be repeated in 1990 on board Promex 3.

Swedish instruments have been sent out for such measurements on board Soviet probes as far as 30 earth radii. They have been made both in the area of the Northern lights and in the Earth's magnetic tail which we drag through space.

"Through the European Space Association (ESA), we have participated in eight satellites," says Richard Lundin, associate professor and project leader for Aspera. "The two probes that are going to Phobos will be the eleventh and twelfth devices that we have built for investigations from space probes."

To Study Mars' Moon

There are also plans for participation in the ESA-probe, Ulysses, to Jupiter with such ion-spectrometers as are used in the Aspera operation. It was meant to start this year and to be launched from the American space shuttle. For well-known reasons it has been delayed. Later that probe--aided by the planet Jupiter's gravitation--will be sent in an orbit around the Sun's polar regions. They have never before been investigated from above.

"Two Soviet space probes are now taking off for Phobos, which is the usual Soviet method for planet investigations," says Richard Lundin. "This Soviet space project has many scientific aims. The main task, however, is a detailed study of Phobos.

"When we take the measurements, both during the fly-by and while close to Mars and Phobos, we will receive rapid and direct reports via the Soviet Space Center. The information will be transmitted to us here in Kiruna, we do not sit in the Soviet Space Center."

Dives Towards Phobos

When the space probe dives towards Phobos, the relative speed will be between six and sixteen feet per second. The probe will then travel across the surface of Phobos at an altitude of 50 meters for about 15-20 minutes.

Before this climax of the space assignment is reached, the Swedish instruments will also have measured the composition and behavior of the plasma that surrounds our outer neighbor-planet, Mars. Since it is not surrounded by the same protective magnetic field as the Earth, the solar winds have considerably greater effect on the Martian atmosphere than they have on ours.

Such a close look at Phobos requires that the advanced auto-pilot of the probe, consisting of an on-board computer and altimeter, receives an exact orbit directive.

When the probe sweeps by at an altitude of only about 50 meters, a number of experiments are begun. Laser and particle beams take soundings of the surface to decide its chemical composition among other things. The dust that whirls up is also measured.

Takes Measurements

Two types of landing modules are released simultaneously with these analyses. One of the modules will drill down under the surface. The other module will "hop around" on the surface of Phobos.

During this phase of the space flight, Aspera will take extensive measurements, both of the natural plasma surrounding Phobos, and of the plasma generated by the particle-beam experiment. (In this connection, plasma is an electrically conductive gas, consisting of free ions and electrons.)

Double Electric Motors

In order to cover as large an angle as possible, the scientists in Kiruna have constructed Aspera in such a manner that 360 degrees can be divided into ten parts. Each "slice" can the cover the whole are while making half a turn.

This is done by Aspera's own two motors (one extra for reasons of reliability). The motor does not use more than one Watt. All of Aspera, which weighs about 8.6 kg, uses an average of about seven Watts. That much is generated by Aspera's own solar panels during the take-off from Earth. The solar panels on Aspera are there to increase the effective budget of the space probe.

In all, Aspera consists of 18 particle sensors, six for electrons (1keV-40keV), and twelve for positive ions (0-30keV). The ion-spectrometers have a magnetic deflection system, which makes it possible to determine the mass of the ions.

Calculates Density And Pressure

Aspera is guided by a powerful 16-bit microprocessor (plus one in reserve). It was described in an earlier issue of NY TEKNIK (1986:40). Its task is to control the spectrometers and the motors, besides handling the data and the transmission to the telemetry system of the probe.

Furthermore, the microprocessor does an extensive processing of the measurements taken by the particle-spectrometers. Among other things, the so-called moments of the distribution function of the plasma are calculated, which gives information of density, flow speed, temperature and pressure.

The flight to Mars and Phobos means a journey of 190 million km through the solar system. After its task on the surface of Phobos, the probe is expected to drift for another 140 days, giving it a total estimated lifetime of 460 days.

During the journey of more than a year, a trajectory of more than 400 million km will be covered. When the probe arrives at Mars, the angle between the Sun, Mars and the Earth will be 40 degrees.

Four Orbital Paths

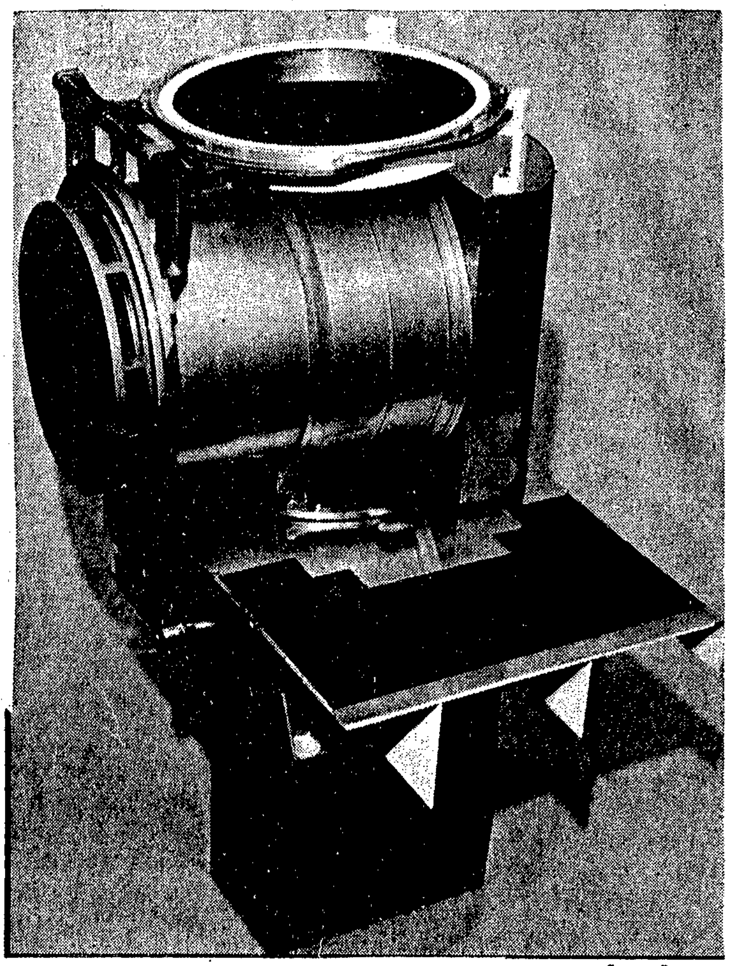
The first two orbital paths around the planet Mars will be strongly elliptical. Orbit 1 has a perigee of 4,200 km and a apogee of 79,000 km and takes about three days. The probe stays in this orbit for 25 days.

Orbit 2 has a perigee of 9,700 km and an apogee of 79,999 km and it also takes three days. There the probe remains for 30 days.

Orbit 3 becomes circular at a distance of 9,700 km from the center of Mars and takes eight hours. That position is then retained according to the flight plan for 35 + 140 days.

Orbit 4 becomes a circular synchronous orbit at an altitude of 9,400 km and takes 7.6 hours. The probe remains there for 30 days and then dives towards Phobos.

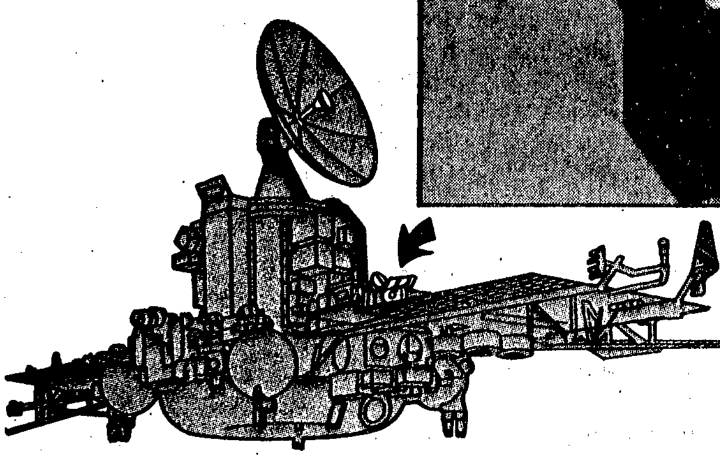
The fifteen minutes when the probe skims over Phobos is obviously the climax of the journey.



This is the mechanical model of "Aspera", built in Kiruna. The upper part consists of the spectrometer module itself with its 360 degree viewing angle. When Aspera enters space, the cover that protects the spectrometer sensors is opened. The solar cells are on the inside of the cover. There are also solar cells on the middle part.

Foto TORBJÖRN LÖVGREN

REGINA RICHTER



Microprocessor: Surface Mounting, IR-Soldering

Stockholm NY TEKNIK in Swedish 12 Oct 86 p 42

[Article by Lars Pekka: "Swedish Microprocessor To Be Sent To Mars"]

[Text] Kalix--"Creativity sometimes requires on to be a lone wolf."

Roland Stralberg, a civil engineer and Urban Erixon, a computer technician in Kalix quit their jobs in order to express their creativity--and developed Sweden's smallest computer chip--a complete microprocessor of 84x29 mm with a weight of 26 grams including software.

Today the microprocessor sits in the nose cone of research rockets and, in a modified form, will accompany the Soviet Mars-probe.

The small chip contains everything necessary for a complete computer: microprocessor, memory, adaptor units for input and output of signals, as well as a power supply and a resetting device in case of interruptions.

The chip is manufactured by means of surface mounting and IR-soldering.

"One prerequisite for making the chip so small is surface mounting," says Roland Stralberg. "Besides the components are more securely attached and can handle vibrations better."

Roland Stralberg is a civil engineer and worked for many years with development at Kalix Electronics Co. Urban Erixon specialized in control-card lay-outs at the same company.

Kalix Electronics primarily developed various types of alarm equipment for the National Telecommunications Administration, among others.

Started Their Own

"Kalix Electronics was a good company, but we felt that our sector became more and more narrow--and we felt that it was still too early for real specializing."

At the beginning of 1986, they left their jobs and started their own company, Microdesign, Inc.

"We knew that the demand for smaller and smaller computer chips was on the increase and we started right in developing a microchip without any orders."

Then appeared a company, Inik. It manufactures star sensors, among other things--navigation instruments for rockets in the Nordic and European space programs. They had strict requirements for the maximum weight and size of computer components and, at the same time, the components had to withstand vibrations.

Stralberg's and Erixon's Chip suited them perfectly.

Reads The Light

It functions in such a manner that an optic sensor reads the faint light from the stars. The light signals are converted to electronic signals which are computer enhanced in Microdesign's microchip to give a position. After the enhancing, the microchip send directional impulses to the steering system of the rocket so that the course is corrected.

That fortunate beginning was an incentive for other customers. The Kiruna Geophysic Institute has a cooperation agreement with Soviet space authorities about sending a plasma spectrometer on a Mars-probe.

Stralberg's and Erixon's little microchip will sit as the "brain" in the spectrometer on the journey to Mars.

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HORIZONTAL-MOLD CONTINUOUS CASTING STEEL-MAKING TECHNOLOGY

Rome BOLLETTINO TECNICO FINSIDER in Italian Jul 86 pp 5-20

[Article by A. Ranieri, Metallurgical Experimental Center]

[Text] Introduction

The technical and economic advantages of continuous casting were understood ever since the end of the last century; however, the ever wider spread of this process in the steel industry did not take place until the last 25 years. Today we cannot conceive of a steel mill without continuous casting.

In 1984, the percentage of continuous casting in Japan was 91 percent in the conversion steel plants and about 79 percent in the electrical steel plants; on an international scale, estimates came to a figure of 56 percent of continuous casting in 1985. In spite of the fact that the idea of casting the metal horizontally was conceived very early, the vertical installations or installations derived from them (Figure 1a, 1b) constitute the vast majority (about 99 percent); we are therefore dealing here with a conventional process that involves many steel qualities and that has reached a high degree of perfection. The horizontal plants on the other hand number only a few dozen (in 1984, there were 43 machines with 64 lines) and numerous improvements are still being made. It must be noted here that the horizontal processes examined in this study are those casting procedures in which the entire process, up to complete solidification, takes place at a constant level very close to the foundation plane (Figure 1c).

We will however not examine some processes which are already being used on an industrial scale or which are being developed and which employ machines with wheels or mobile ingot molds; their height is limited. This point might perhaps be the subject of a coming study.

Table 1 in summary form presents an overall picture of the state of utilization of conventional and horizontal continuous casting plants.

Three types of horizontal machines are presently available:

machines for square billets with sides of between 55 and 250 mm and round billets of between 55 and 330 mm;

machines for round and square bars of between 25 and 50 mm;

machines for wires suitable for the production of wires and bars of between 3 and 12 mm.

The range of horizontally cast steels is rather broad and includes carbon steels, low-alloy, medium-alloy, and high-alloy steels, as well as inoxidable steels.

In spite of the limited quantitative rate of the process, we can detect growing attention being devoted to the horizontal process primarily by steel plant operators interested in manufacturing small lots of highly-alloyed steels that cannot be conveniently produced in conventional machines for metallurgical and economic reasons.

Some recent development under study could however lead to the elimination of the limitations on the horizontal process, consisting of the particular suitability for small lots.

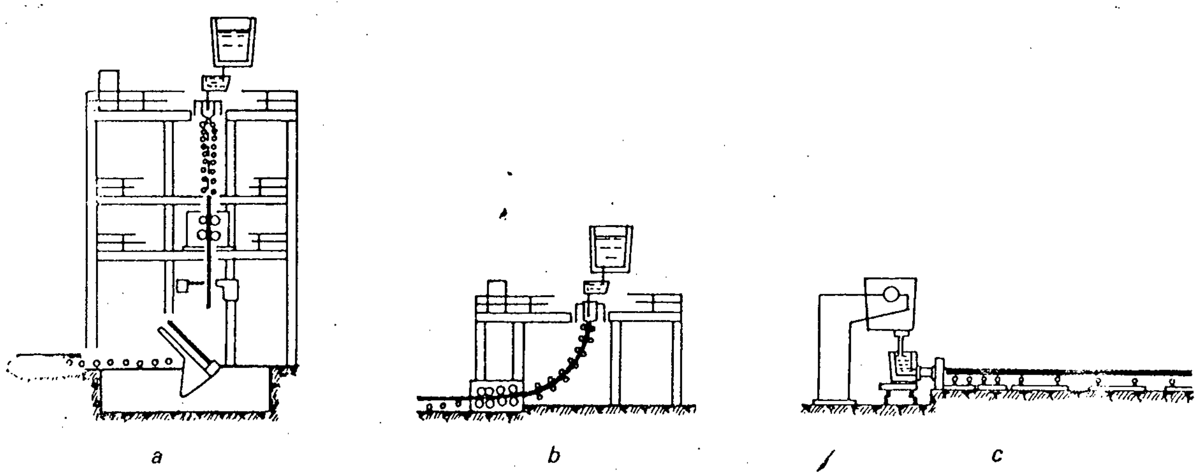


Figure 1. Continuous steel casting processes. (a) vertical continuous casting; (b) curved continuous casting; (c) horizontal casting.

Table 1. Current status of utilization in continuous-casting plants

	1 bramme	2 blumi	3 billette	4 tondi	5 colata continua orizzontale
dimensioni 6	600/2600 x 150/350	130/400 x 200/600	70/200 x 70/200	ø 110 / ø 420	40 x 40, ø 40 / 220 x 220, ø 330
capacità max, tpa x linea 7	1 500 000	200 000	100 000	160 000	50 000
impiego preferenziale 8	9 grossi tonnellaggi	9 grossi tonnellaggi	10 tonnellaggi piccoli e medi	11 tonnellaggi grandi e medi	12 piccoli tonnellaggi; fabbricazioni speciali
applicazione 13	14 prodotti piani	15 prodotti lunghi	15 prodotti lunghi	16 tubi	15 prodotti lunghi

Key:
1. Slabs
2. Blooms
3. Billets
4. Rounds
5. Horizontal continuous casting
6. Dimensions
7. Maximum capacity, t/yr x line
8. Preferred use
9. Heavy tonnages
10. Small and medium tonnages
11. Heavy and medium tonnages
12. Small tonnages, special products
13. Practical application
14. Flat products
15. Long products
16. Pipes

Historical Background

The first promising practical uses of horizontal continuous casting of steel on a pilot scale came at the beginning of the 1960's in the USSR (1962), in the United States (1965), and in Great Britain (1966).

In the USSR, the first development took place at the Ukrainian Metallurgical Research Institute. The pilot machine provided for a 150-kg open basket which oscillated together with ingot mold according to a concept which was only recently picked up again.

This led to the development of a machine with a fixed ingot mold with two lines weighing 20 t and supplied by 10-t buckets that made it possible to obtain round and square bars up to 200 mm (Tulachermet).

At that time, there were not many billet machines that were supplied with large-size ladles because of the considerable design and operating difficulties inherent in multiline machines of the curved type.

In the USSR, it was assumed that it might be possible more economically to attain the objective of continuous casting of billets on a vast scale by starting with the two-line horizontal continuous casting module.

A subsequent economic study (1978) concerning the production of billets to be rolled into section steel (1 million t/yr) indicated that, for dimensions of 150 x 150 of the semifinished product, one would have to have four machines with six lines, supplied by an electric steel mill with four furnaces of 100 (1) (at this time, two would be enough). Looking ahead, the analysis concluded that, in the case in question, the economic advantages of horizontal continuous casting were rather limited (cost reduction of about 2 percent). On the basis of this analysis, the horizontal continuous casting process was judged to be suitable rather for electrical steel plants equipped with small-capacity and medium-capacity furnaces oriented toward specific products.

The demand for multiline horizontal continuous casting machines supplied by large-capacity ladles however is still making itself felt; pertinent projects are probably being studied (Mannesman, Voest [United Austrian Iron and Steel Works, Inc.]); work has recently been done along these lines also in the USSR.

The industrial use of horizontal continuous casting in the United States took place on the basis of entirely different assumptions; work on a pilot scale was begun by GM (2, 3, 4) in connection with the demand for recycling the in-house scrap from the plant's mechanical processing stages and to make structural steel in the form of bars, thus achieving savings as compared to the sale of scrap and the purchase of bars from outside suppliers.

GM in this way developed its own horizontal continuous casting process (X--True Cast); in 1971, it was operating three plants with one line for rounds of 60/96 structural steels (6 C up to 0.5 percent) for use in auto parts (about 300 t/yr); the in-house scrap was recast in two 10-t blast furnaces. Under the market conditions prevailing during the 1970's, GM saved 15 percent. In 1982, the GM plant was closed because of the reduced demand which would have involved turning out uneconomical and discontinuous operations below the capacity of 50,000 t/yr.

A nonexclusive license on the GM process was obtained by Technica-Guss (T.G. of Wuerzburg which already had its own knowhow for horizontal continuous casting.

In 1977, a GM-TG plant was installed at Bohler in Duesseldorf whose primary objective was to cast steels with a high Ni and Cr content in the form of 96-mm rounds, as well as expansion to the casting of square billets. This plant--which, as regards refractory materials and the ingot mold, adopted the GM technique--was operated in a satisfactory manner, thus making it possible: (i) to cast and figure out a large number of alloy compositions; (ii) to obtain square 80-mm billets.

In 1966 and 1967, the British Davy-Ashmore Company (5, 6), according to its own original ideas, developed a project involving a horizontal continuous-casting machine which, it was believed, would be able to overcome the difficulties connected with the dissolution of the graphite in the ingot mold and the problems of the combination of ingot mold and refractory materials. During the final stage of industrial development, an agreement was worked out with NKK which, in 1978, had started a two-line plant at Fukuyama Establishments on which it continued work to develop the process which has nw reached full sales maturity and which is called Horicast.

Various other companies recently became interested in horizontal continuous casting; Sumitomo Metals and Kobe Steel built and conducted experiments on their own pilot plants. Krupp is also working, on a pilot scale, on a plant which goes back to the original concept of simultaneous movement of the ingot mold and the basket (see below); it is doing so because of the special quality requirements arising from some steels.

The further development of horizontal continuous casting will be oriented toward the following:

the increase in the dimension of the semifinished products, parallel to an increase in the capacity of the machines;

the extension of the range of cast steels;

improvement of surface and internal qualities (design of specific electromagnetic beaters and optimization of their action).

The following procedures assume outstanding industrial importance against the background of the current state of the art:

Horicast (Davy--NKK),

GM--Technica Guss,

processes developed in the USSR (Ukrainian Metallurgical Research Institute, Tulachermet).

Characteristics and Problems of the Horizontal Continuous Casting Process

In comparison to the conventional continuous casting process, horizontal continuous casting differs by virtue of the direct link between the basket and the ingot mold and because of the absence of the curvature of the bar.

From this springs: (i) the absence of secondary oxidation of the liquid steel to the advantage of the inclusional state; (ii) the possibility of more easily casting steels with a high content of $A/_{sol}$ and very reduced cross-sections; (iii) the particular suitability for high-quality casting of steels having a tendency toward the formation of cracks (due to the absence of the bar's curvature).

To these characteristics we must add that:

the absence of casting dust permits more intensive heat removal in the ingot mold and does not involve any subsurface inclusions; there is however a risk of greater wear and tear and of sticking;

the high ferrostatic pressure in the as yet not solidified down-line section of the bar eliminates any problems of bulging;

in horizontal casting, given the absence of a natural meniscus, at the start of formation of the shell, we must resort to an artificial meniscus [lens]; the success of the horizontal continuous casting process depends on the solution of this problem; in practice, one uses a special refractory component, the so-called "separation ring" whose function and nature will be illustrated in greater detail below;

in horizontal continuous-casting processes, inclusions cannot become separated from the bar, thus rising to the surface, which is why the inclusional state of the steel, that supplies the basket, must be checked;

similar to what happens in many arc machines, we find separation due to the gravity of the nuclei with accumulation of equally oriented crystals in the lower half of the bar, while columnar crystallization prevails in the upper half; this asymmetry can be corrected with different countermeasures;

the length of the liquid core (metallurgical length) and the quality problems connected with it are phenomena that depend on the position and that can be tackled in a manner similar to the vertical continuous-casting processes (optimum superheating, electromagnetic heating).

Table 2 summarizes some of the differences between vertical and horizontal casting. From the economic viewpoint, horizontal continuous casting presents the following positive features:

smaller investments due to the reduced height and the limited space requirement; a horizontal continuous-casting plant can often be put into existing steel plants without any particular difficulties;

reduced manpower needs; the workers assigned to the basket and to the dust admixture section, still to be found in some vertical plants, are as a matter of fact superfluous;

reduced maintenance expenditures due to the smaller number of mechanical and structural parts and the greater simplicity of the cooling system;

greater safety for operators (reduced height, plant design features, etc.).

Table 2. Differences between vertical casting and horizontal casting

	Vertical	Horizontal
Direct link between ingot mold and basket	No	Yes
Dumper dimension	Small	Limited by diameter of ingot mold
Steel speed	High	Low
Ferrostatic pressure, kg/cm^2	8–10	1
Influence of gravity on formation of bar's shell	Constant at periphery, variable according to length	Variable at periphery, constant in direction of length
Extraction of bsr	Continuous	Cyclic (*) (or discontinuous, at slow pace, go-stop)
Movement of ingot mold	Oscillatory	Absent (*)

(*) Some of the recent pilot machines constitute an exception.

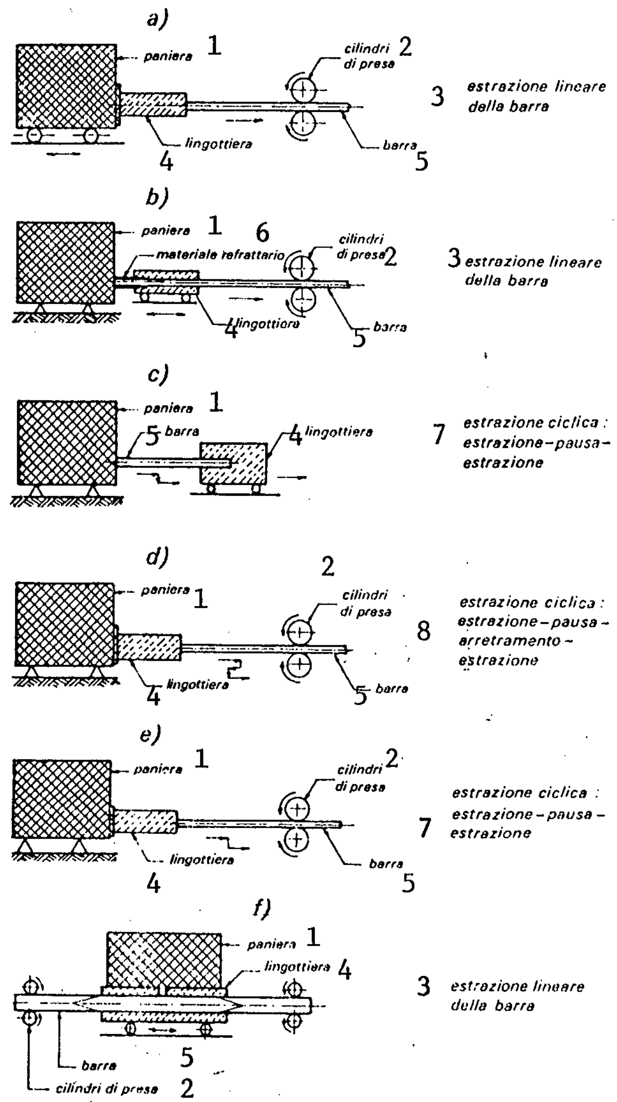
On the other hand, they are disadvantageous from the economic viewpoint:

high cost of separation ring in individual castings;

high cost of ingot mold because of the wear and tear to which it is subjected.

The process furthermore involves a highly complicated operation along with (i) difficulties in precisely defining the extraction cycle; (ii) system's sensitivity to trouble; (iii) demand for very precise measurements of the extraction cycle and the shell formation.

Figure 2. Operating principles of continuous-casting plants



Key: (a) Ingot mold and oscillating basket complex
(b) Oscillation of ingot mold
(c) Watts process
(d) Oscillation of bar
(e) Oscillation of bar
(f) Bilateral extraction machine

1. Basket
2. Holding cyclinders
3. Linear extraction of bar
4. Ingot mold
5. Bar
6. Refractory material
7. Cyclic extraction: extraction--pause--extraction
8. Cyclic extraction: extraction--pause--backup--extraction

Horizontal Continuous-Casting Technology

Looking at the current state of the art, horizontal continuous-casting processes allow a large number of operational variants which are summarized schematically in Figure 2, above; they differ from each other (7) depending on whether, when it comes to the extraction of the bar, there is:

oscillation of the basket and the ingot mold and continuous extraction to form a bar (also bilateral);

oscillation of ingot mold and continuous extraction;

oscillation of bar and cyclical extraction according to the following methods: (i) extraction, pause, extraction; (ii) extraction, pause, backup, extraction.

In practice, the majority of the horizontal continuous-casting plants currently in operation definitely employ cyclical extraction; however, the study of continuous extraction was never entirely abandoned.

Connection Between Basket and Ingot Mold

The horizontal system would not present such big problems if, as in the case of nonferrous metals and cast-iron, the temperature of the bath were such as to make it possible to get into the basket with a refractory element that would be in one part with the ingot mold, the latter being cooled only in the terminal part. In the case of steel, this is impossible and it required a rather laborious effort to come up with industrially useful solutions.

Figure 3 illustrates the different ways of providing for the connection between the basket and the ingot mold in the case of nonferrous metals and steel.

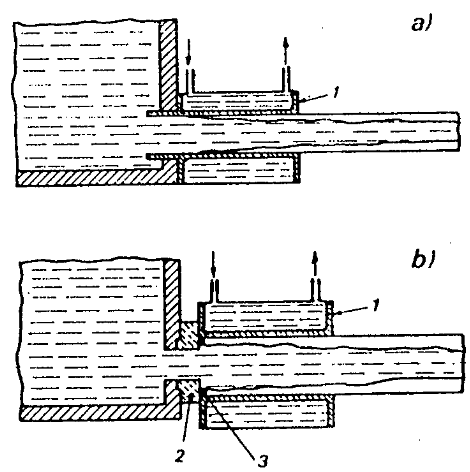


Figure 3. Link between basket and ingot mold in casting nonferrous metals and steel.

Key: 1. Ingot mold
2. Dumper
3. Separating ring

(a) Nonferrous metals
(b) Steel

In the case of steel, the connection between the basket and the ingot mold called for the use of a refractory component with critical characteristics, the so-called separation ring (break ring) (8, 9). This ring is generally made with special materials (BN, Si_3N_4 - BN) and is placed at the boundary between the liquid-phase zone and the solidification zone (artificial lens outlining the solidification zone on the basket side).

The refractory component of the break ring must:

guarantee the absence of infiltrations of liquid metal into the junction;

fix the start of the solidified zone as of a well-determined and constant point;

prevent occlusion in the dumper due to solidifying if the steel's temperature goes down.

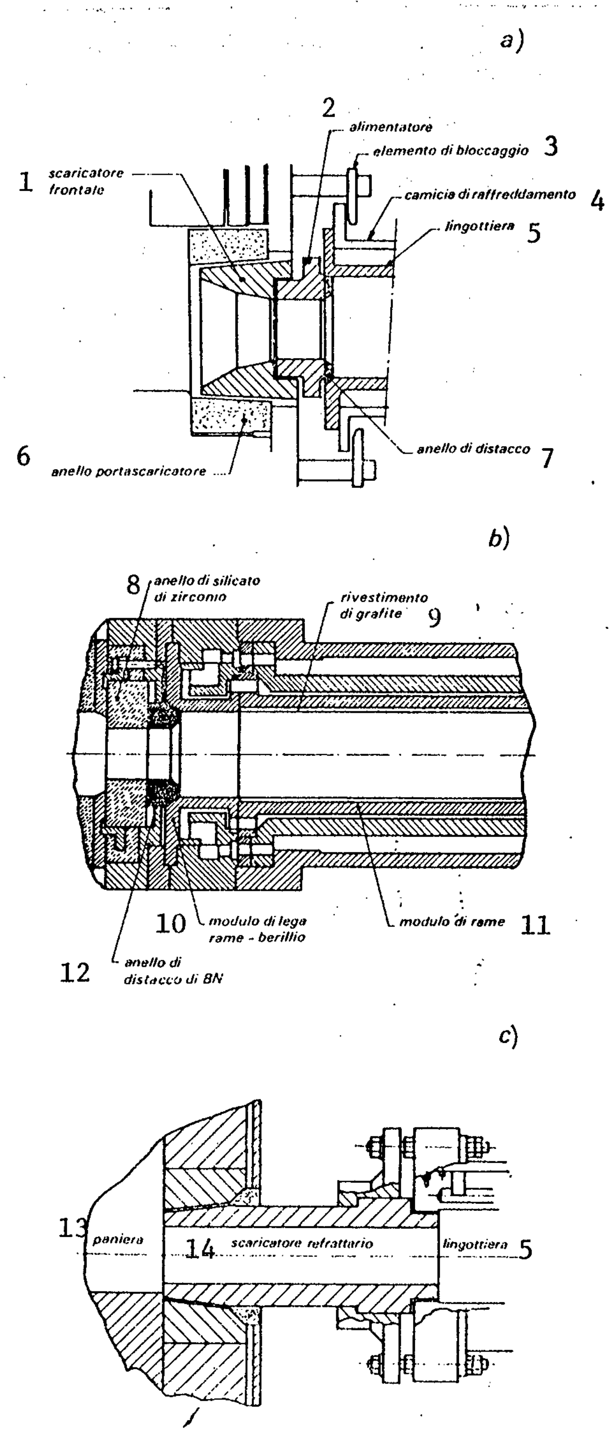


Figure 4. Link between basket and ingot mold. (a) Horicast plant; (b) GM--TG plant; (c) Plant of the Ukrainian Metal Research Institute (Danieli license).

Key:

1. Frontal dumper	6. Dumper-carrier ring	11. Copper module
2. Feeder	7. Break ring	12. BN break ring
3. Blocking element	8. Zirconium-silicate ring	13. Basket
4. Cooling sheath	9. Graphite cover	14. Refractory material dumper
5. Ingot mold	10. Copper-beryllium alloy module	

In horizontal-casting machines, the connection between the basket and the ingot mold assumes particular importance because it determines the stability and duration of casting and the product's surface quality.

From the refractory viewpoint, the requirements for the break ring are as follows:

high degree of refractoriness,

low dilation coefficient,

adequate resistance to heat fracture,

resistance to erosion on the part of the liquid steel,

dimensional precision.

This subject will be taken up again and covered in detail below.

Figure 4 shows the details of the link between the basket and the ingot mold which is typical of various processes adapted for industrial purposes.

We can easily see that the maximum dimensions of the break ring determine the maximum dimension of the bar. In the case of the Soviet plant at the Ukrainian Metallurgical Research Institute (further developed by Danieli), the connection between the basket and the ingot mold is considerably simpler. There is no break ring but rather a special connection dumper which is tapered on the side of the basket and which is cylindrical on the ingot mold side and for which experiments involved the use of melted silica, corundum, mullite, and zirconium oxide.

The best results, according to Russian experience, reportedly were obtained by adopting a graphite-treated silico-aluminous material and a special refractory cement for the connection to the ingot mold and for the protection of the pertinent frontal zone. The absence of the break ring made of special refractory material is presented as an economic advantage (10) (the BN reportedly is ten times more expensive than the conventional refractory materials); this solution however would have some negative effects on the product's quality.

The Sumitomo experiments with refractory materials on a base of oxides, including Al_2O_3-graphite, showed a decline in the surface quality of the semifinished product, irregularities of operation and infiltration of metal into the junction areas at the end of the casting.

The refractory performance of the Soviet horizontal continuous-casting machine is an isolated example at this time.

Bar Solidification and Extraction Process

The cooled ingot mold and the extraction device are the most important parts of the horizontal continuous-casting plants.

The solidification mechanism is strictly connected to the method of bar extraction which, in a manner similar to what has already been done for cast-iron and nonferrous metals, takes place in a cyclical manner.

Continuous extraction experiments performed by Sumitomo--most likely repeating the experience of other steel makers (11)--confirmed that the continuous procedure with the fixed ingot mold results in serious damage to the bar's surface and entails the risk of rupture.

The cyclical procedure (7) provides for a series of extraction impulses which bring about shifts of the bar with respect to the fixed ingot mold; these shifts are between 10 and 30 mm and are spaced apart by very short pulses during which solidification takes place (80-150 impulses per minute). The rate of extraction and stopping cycles varies slightly in the different procedures. The formation of the shell is illustrated in a simplified manner in Figure 5.

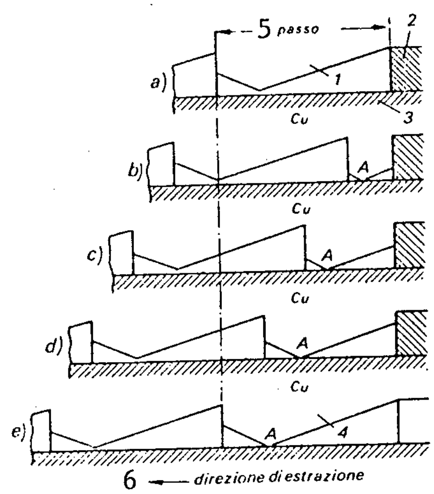


Figure 5. Bar formation mechanism in the horizontal process with cyclical extraction.

Key: (a) Pause
(b) Extraction
(c) Extraction
(d) Extraction
(e) End of extraction

1. Shell of bar
2. Break ring
3. Copper ingot mold
4. New shell of bar
5. Step
6. Direction of extraction

In section (a) we can see the situation at the end of a cycle with the shell which was formed during the cycle itself, sticking to the break ring. At the beginning of the run (section (b), the shell is removed from the break ring and new liquid steel can flow in, occupying the volume that was released between the shell and the ring.

Because of the cooling conditions, the metal is solidified both in correspondence to the break ring and the preformed shell according to a profile that resembles the one in section (b).

The two solidification fronts converge at point A where, during the run, we assume that melted metal is always present. Throughout the entire run, the two solidification fronts grow further, as indicated in sections (c) and (d). At the end of the cycle, a new bar shell is formed which, at point A, is considered to be separated from the old shell because of the presence of melted material (section e). Whenever we provide for a backup phase, also to compensate for contraction in a longitudinal direction (pushback), a solid link will form between the new bar and the old bar so that, upon the successive traction, the shell of the newly-formed bar is removed in one piece from the break ring.

The mechanism described here explains the presence, on the bar, of oscillation (or crystallization) traces due to solidification corresponding to the break ring and at convergence point A of the solidification fronts (respectively, pull marks or cold witness marks or cold shuts and hot witness marks or hot spots).

As a result of the abandonment of the terminology that sprang from steel mill operation, we increasingly frequently encounter the use of the term primary oscillation trace for pull mark and secondary oscillation traces for hot spots.

The intermittent extraction mechanism considerably broadens the possibilities of working on the operational variables with respect to continuous extraction, pure and simple.

The asymmetrical growth of the shell in the ingot mold (which is more pronounced in keeping with the break ring) is explained in flow-dynamics terms. In the zone adjacent to the break ring, there would appear to be a recirculation of the liquid metal which would obstruct a continuous contribution of new hot material.

A suitable extraction cycle represents the basic premise for safe operation and satisfactory quality; this is why forward movements, pauses, backup movements, speed, accelerations, and decelerations must be within narrow intervals.

Figure 6 shows examples of extraction cycles at coordinated extraction—time speeds.

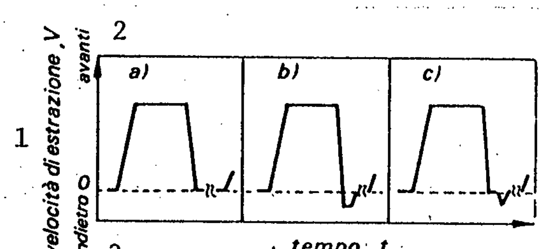


Figure 6. Examples of extraction cycles.

Key: (a) Extraction—pause—extraction
(b) Extraction—pause—backup—extraction
(c) Same as (b) except for different method during backup phase

1. Extraction speed
2. Forward
3. Back
4. Time

The casting cycle is optimized as a function of the steel quality, the cross-section of the semifinished product, and the casting speed.

To achieve this, the operation as such must make it possible to work on the following:

startup acceleration,
extraction speed,
step of cycle,
speed of stoppage,
entity of stoppage,
time of pause.

Figure 7 shows cycles with different initial acceleration; this is a variable of an important process; as a matter of fact, since the ferrostatic pressure in horizontal continuous casting is low (a pressure of 0.56 bar corresponds to a bath height of 800 mm), there can be a depression during the acceleration phase with a drawing of air through the refractory material; this effect can cause the presence of subsurface porosities.

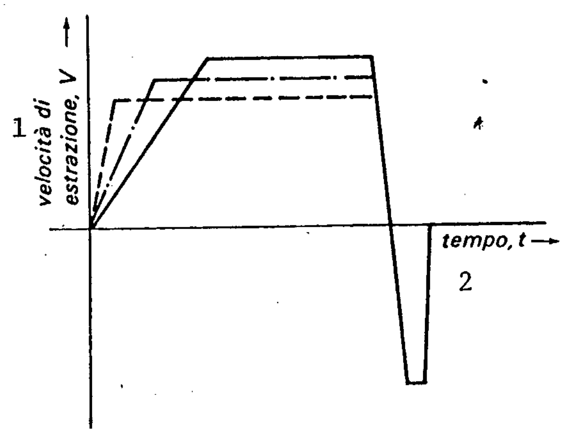


Figure 7. Extraction cycles with different initial accelerations.
Key: 1. Extraction speed 2. Time

The effect of other parameters of the cycle is shown in Table 3 (12).

Table 3. Extraction cycles performed at equal casting speed.

	1 ciclo	2 spostamento, mm	3 tempo, sec	4 velocità, m/min	5 cicli/min
caso I 6 7 8	 arretramento pausa	15,0 1,0 0 14,0	0,25 0,05 0,20 0,50	3,6 1,2 0 1,7	120
caso II 10 11 9 8	estrazione arretramento pausa	15,0 1,0 0 14,0	0,35 0,05 0,10 0,50	2,6 1,2 0 1,7	120
caso III 10 11 12 8	estrazione arretramento pausa	10,0 0,05 0 9,4	0,17 0,03 0,13 0,33	3,6 1,2 0 1,7	180

Key:
1. Cycle
2. Shift
3. Time
4. Speed
5. Cycles/min
6. Case I
7. Stoppage
8. Pause
9. Case II
10. Extraction
11. Stoppage
12. Case III

In case I, the casting speed is 1.7 m/min; if the extraction speed of 3.6 m/min is too fast, we can go down, for example, to 2.6 m/min; at equal casting speed (productivity), this however implies a reduction of the pause to 0.10 sec (case II). If, on the other hand, the oscillation traces are too pronounced, we can reduce the extraction step to 10 mm; at the same time however the pause is reduced to 0.13 (case III). The number of cycles per minutes is important for quality purposes; an increase in this frequency is generally positive but the optimum value depends on the type of steel.

In conclusion, we can say that cyclical extraction is a rather complex process during which each individual phase must be performed in a manner rigorously reproducible in terms of space and time.

The diagram in Figure 8 (13) in its quadrants shows the relationships between casting speed and the main parameters of the process of horizontal continuous casting. In the diagram, all magnitudes that directly influence the productivity are indicated with g (for example, v_g, f_g, and l_g, respectively, are the casting speed, the frequency, and the extraction step [pace]); the magnitudes pertaining to extraction are indicated with z (for example, t_z is the extraction time, ms); R indicates the stopping phase between the cycle (for example, t_R is the stopping time).

For further details pertaining to the relationships expressed by the diagram and their practical application, the reader is referred to the work cited (13).

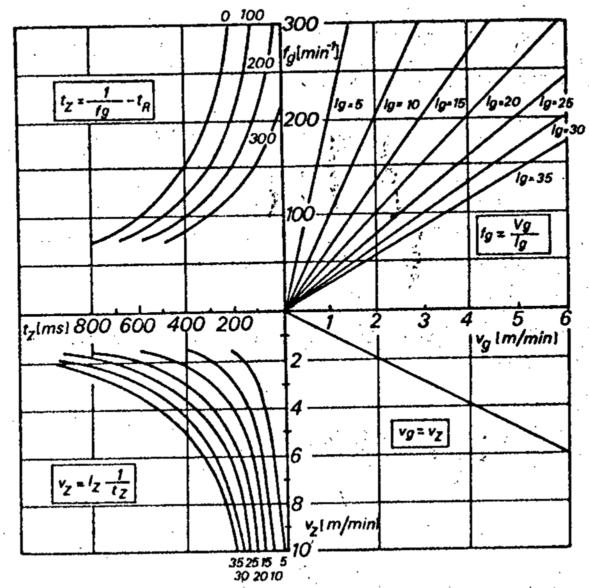


Figure 8. Relationship between casting speed and process parameters in horizontal continuous casting.

Investigations on Models

The development of horizontal continuous casting is still in a rather incomplete stage when compared to vertical continuous casting; we therefore continue to face a major need for improving our basic knowledge following the by now classical route of resorting to physical and mathematical models.

The results of these studies, which yield quantitative expressions relative to the specific aspects of the process, are of considerable interest both to the horizontal continuous-casting machine builders and to the steel mill operators.

In 1976, Szekely analyzed the Watts process (14) which is characterized by a closed mobile ingot mold and a free bar (Figure 2c). He studied the following: (i) the process of increasing the cross-section of the tubular solidification shell; (ii) the maximum distance between the ingot mold and the basket. This distance is determined by the difficulty of supplying the metal and varies between 300 and 500 times the width of the bar.

As regards cyclical extraction processes, studies conducted with the help of models involved the following:

initial solidification;

temperature distribution in the ingot mold;

secondary cooling;

the bar's viscoelastoplastic performance.

Jacquemar et al. (15) assumed that heat exchange in the process with intermittent extraction takes place through conduction and convection; a differential expression is formulated here which takes into account the dynamic equilibriums, the energy balances, the continuity of influx of the melted mass to the solidification front which is moving parallel to the prior solidification front. It follows from the model that the solidification speed is high during the initial stages and that it then declines with the passage of time.

Figure 9 shows the progress of heat flow in the case of vertical and horizontal continuous casting; at 400 mm from the lens (vertical continuous casting) or, respectively, from the break ring, the difference between the initially very significant heat flow turns out to be less accentuated.

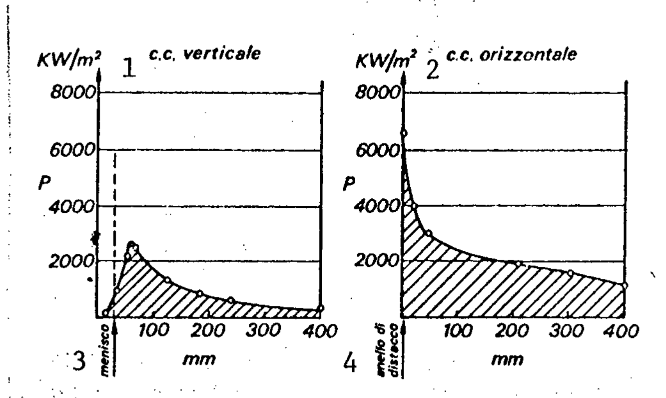


Figure 9. Progress of heat flow in vertical continuous casting and horizontal continuous casting.
Key: 1. Vertical continuous casting 3. Lens
2. Horizontal continuous casting 4. Break ring

Figure 10 shows the process of solidification as derived from calculation; immediately after the start of solidification, it melts in the contact region between the break ring and the billet formed earlier and the lack of uniformity in the thickness is considerable but agrees with what we can derive from rough calculations for a sawtooth solidification shell as noted in the literature. When the billet, after 4.8 sec, leaves the copper zone of the ingot mold, the lack of uniformity in the solid shell is already negligible and we can rule out the formation of "solidification points" (bridging). Schneider (16) analyzed the energy balance under boundary conditions corresponding to the solidification front and to the surface of the ingot mold in horizontal casting with intermittent extraction of pure metals; he examined the solidification mechanism in correspondence to the solidification shell in motion and to the break ring.

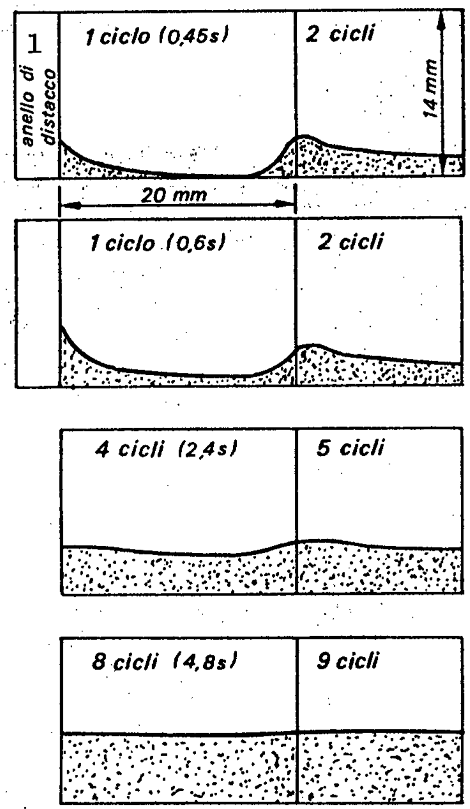


Figure 10. Progress of solidification (calculated). t = 0.45 sec at end of first extraction phase; t = 0.6 sec at end of cycle; t = 4.8 sec, situation at exit of bar from copper section of ingot mold.
Key: 1. Break ring   ciclo--cycle
                                  cicli--cycles

Rammerstorfer et al. (17) studied the performance of the material of the bar between the holding cylinders and the ingot mold; using the method of finite elements, they calculated the reaction at the origin of the bar during the cyclic movement due to the action of the holding cylinders, performing almost static heat-visco-elasto-plastic and dynamic analyses. The cyclic progress of the extraction speed imposed by the holding cylinders turned out to have been changed by slippage effects and, to a more marked degree, by inertia effects.

Among the improvements to be made, we might mention the following:

better modelling of boundary conditions corresponding to the start of the bar (suppression of backup of bar during growth phase);

more pronounced spacing of bar particularly in zone of ingot mold;

adoption of a variable abrasion coefficient in the various zones of the ingot mold in order better to illustrate the local conditions.

Plant Facility Aspects and Their Development Tendencies

Basket

In horizontal continuous casting, likewise, the basket has the job of ensuring a constant content of liquid metal in the ingot mold regardless of the level in the ladle and of providing for a balanced distribution between the lines.

The dumper of a horizontal continuous-casting basket is not accessible during operation; to prevent clogging, it is therefore necessary to maintain adequate overheating (for example, with an induction system); this also permits casting operations that are prolonged in terms of time. The design of the basket can be based on two alternatives (12):

large-capacity basket,

small-capacity basket.

Large-capacity baskets can contain two castings (for example, 40 t for castings of 25 t) and they differ substantially from those of vertical continuous casting.

The small-capacity baskets (for example, from 7 t) are used only as a reserve of liquid metal and seem to be more widespread. For decanting the inclusions, the small-capacity basket is sufficient; however, as the capacity grows, the induction heating system becomes more complex.

In the current state of the art, the technique of the large-capacity basket remains yet to be perfected. Figure 11 A and B shows a nonheated basket (NKK) and a basket equipped with an induction heating element (VOeEST).

The horizontal continuous-casting basket is equipped with a special dumper on the ingot mold side which--being subjected to major heat jumps--is a part with high quality characteristics (for example, on a base of ZrO_2).

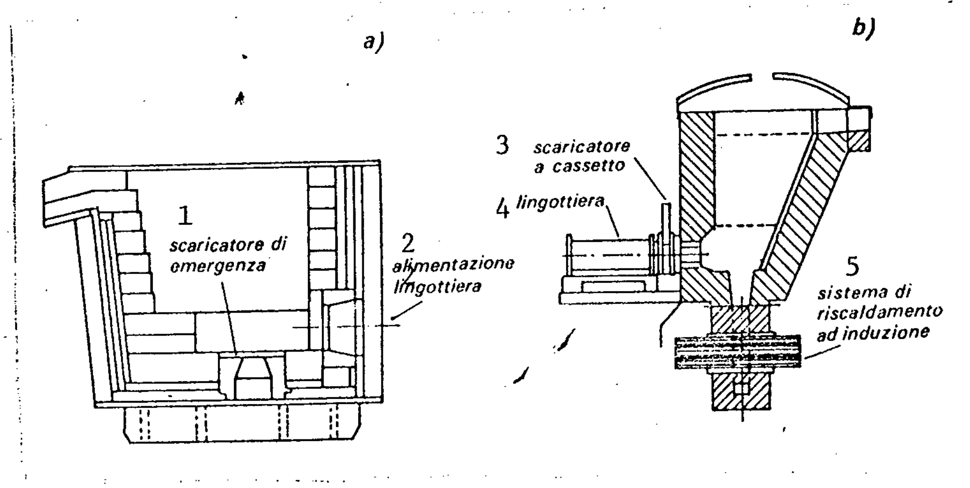


Figure 11. Horizontal continuous-casting basket of varying design. (a) Horicast basket; (b) Basket with induction coil.

Key: 1. Emergency dumper
2. Ingot mold feed
3. Box dumper
4. Ingot mold
5. Induction heating system

Break Ring

The critical nature of the conditions under which this component works--a component whose function was illustrated earlier--required the employment of new refractory materials which until now had not been used in the steel industry. The refractory material of the break ring must have:

resistance to heat stress and to heat fracture,

resistance to erosion and abrasion,

good workability and dimensional precision.

Figure 12 shows (9) the development of the temperature inside the ring after 50 sec following the start of casting; as we can see, the temperature gradients inside it are very high and the stresses therefore are quite considerable; the distribution of these stresses is shown in Figure 13.

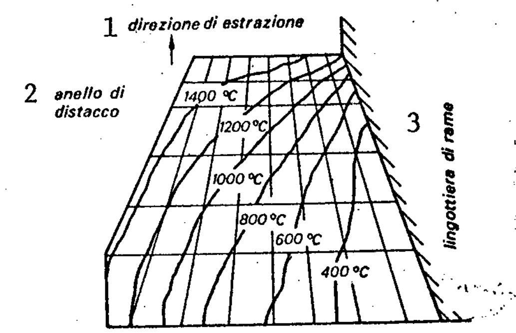


Figure 12. Development of temperature in break ring.
Key: 1. Direction of extraction 3. Copper ingot mold
2. Break ring

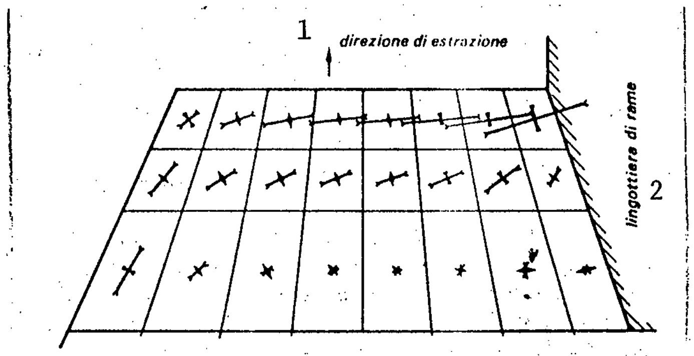


Figure 13. Distribution of maximum and minimum compression and traction stresses inside break ring. Note: 1. ↣↢ compression stresses; ⟵⟶ traction stresses; 2. Stress level ⟷ 1 t/cm^2
Key: 1. Direction of extraction 2. Copper ingot mold

At the beginning of the development of horizontal continuous casting, the break ring was most of the time made of BN, a very expensive refractory material. For the Horicast plants, NKK, after proper experimentation, started the industrial use--for high-carbon steels--of a material made up of Si_3N_4 with limited additions of BN (5-15 percent) dispersed uniformly in the structure of Si_3N_4 linked directly through reaction.

For casting inoxidable steels, plants began to use rings made of Sialon, a synthetic refractory material, whose composition can be illustrated by the following general formula:

$$Si_{6-z}Al_zO_2N_{8-z}$$

Tests with Sialon of varying composition showed that the optimum results as regards resistance to erosion and heat fracture can be obtained with Sialon material where Z = 1.

Using Sialon rings, it was possible to cast inoxidable steels in round bars of 330 mm.

A new process of obtaining Sialon calls for a mild presintering of dust in the metallic state which is followed by mechanical working very close to the final shape and, at last, nitriding at high temperature. The standard sintering and hot-pressing procedures make it possible to obtain very high mechanical properties but final working for rectification is very burdensome. In the process of sintering through chemical reaction, mechanical working is almost complete in the metallic state. With this material it is possible to make rings with a maximum diameter of up to 350 mm. The new compound consisting of Sialon and boron nitride offers excellent tenacity, resistance to oxidation, and heat jumps. The good resistance to corrosion on the part of the inoxidable steels and to Cr-Mo makes it particularly suitable for the manufacture of parts that come into contact with liquid steel.

The thermal properties of the material of the break ring do influence the depth of the oscillation traces; the depth of these traces can be reduced (i) by using an Si_3N_4-AIN-BN compound which presents conductivity (5-10 Kcal/m·h·^{o}C equal to 1/3-1/4 of those of BN; (ii) by modifying the geometry of the junction between the ring and the ingot mold (less accentuated step).

Not many data were made known regarding the speed at which the ring wears out; for Si_3N_4-BN material (5-15 percent), it was estimated at 0.7 mm/hr.

To contain the erosion on the part of the liquid steel, the dimensional pressure must be very high ($\pm$0.005 mm).

Ingot Mold

The ingot mold is made up of several parts among which the copper module and the water jacket are the critical components.

Because of the high operating temperature, we use alloys of copper with high heat resistance (copper-chrome-zirconium and copper-beryllium). At the GM-Technica plants, primary cooling takes place in two stages: for the first 200 mm from the intake opening of the steel, the ingot mold is made of Cu-Be alloy, hardened through precipitation; next follows a section of 900 mm where the copper sheet of the ingot mold is swathed by a sheath of graphite which, in addition to eliminating the heat, performs a lubricating action.

The Horicast process employs a copper-alloy ingot mold which is 300-450 mm long.

In horizontal continuous casting, the problem of lubricating the dust of the ingot mold turns out to be very difficult. Every horizontal continuous-casting process developed its own lubrication methods. The wear in the ingot mold differs according to the type of steel and is much greater in the case of inoxidable steels as compared to carbon steels.

Other solutions that were adopted--in addition to the previously mentioned graphite sheath--call for special metal linings on the inside surface of the ingot mold.

A lining of nickel-chrome, using a special lubricant, was adopted in the Horicast process.

For casting inoxidable steels (18), Sumitomo tested a nickel lining containing, in dispersion, 15 percent fluorided graphite $(CF)_n$; in this way we get a reduced wear coefficient (0.1-0.2) which is a big help to the start and regular progress of casting.

In the case of carbon steels, the inside lining can be eliminated by, beforehand, applying a film of 100 mu of solid lubricating mixture (25 percent Cu dust, 25 percent lithium silicate, and the rest graphite).

One can also get acceptable results by using only molybdenum, MoS_2, applied in the form of a film upon the inside surface (wear coefficient 0.2); in this way, it was possible to cast 180 m of billets or of rounds with a diameter of 110 mm without any trouble.

Ingot molds of copper and of inoxidable steel, which do not require any special linings, have recently been adopted successfully for casting carbon steels.

Extraction Devices

Extraction devices together with the ingot mold are the components that required most in terms of development work.

The following are currently in use:

the holding-cylinder system,

the shoe system (Mannesmann).

The cylinder system is the most common; however, as the dimensions of the bar grow (beyond 200 mm), a single pair of cylinders is no longer enough to transmit the extraction forces to the bar. In this case one uses more pairs of cylinders; the operation becomes more complex and expensive while the space requirement increases so that the use of these mechanisms becomes less flexible, especially in machines with more lines, when one wishes to keep the distance between the lines as small as possible.

This is why Mannesmann experimented with a shoe system with oil-dynamic operation (19, 20, 21).

The blueprint of this extraction system is based on the following assumptions:

maximum cycle frequency 3 Hz,

possibility of adoption not tied to the dimensions of the semifinished product, hence, not tied to its weight, use on machines with several lines.

The device consists of two cylinders per line which carry clamps with grasping shoes and which work alternately holding or in the return phase going back to the initial position so that the bar will move but will never be free and so that there will be no uncontrolled shifts of that bar.

The device's operating principle is illustrated in Figure 14.

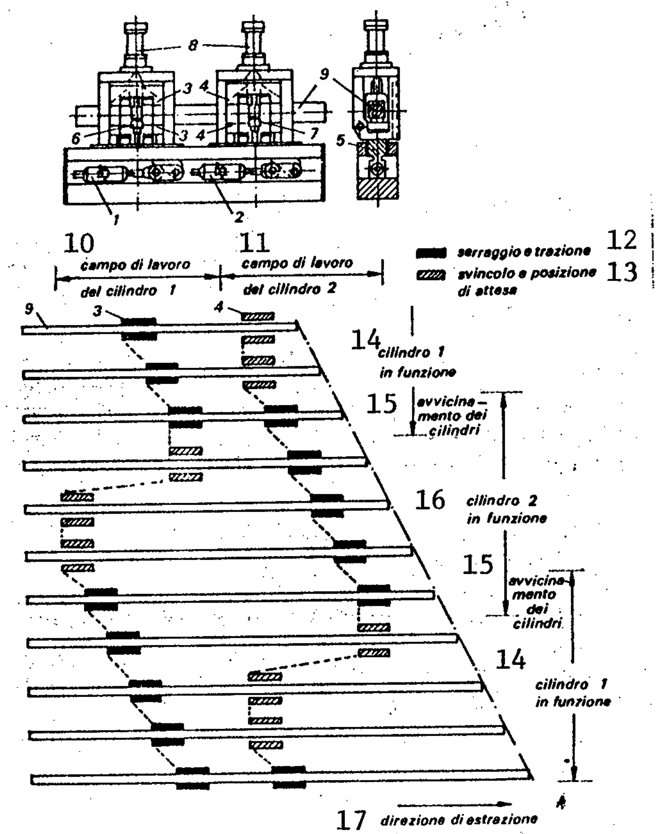


Figure 14. Operation of shoe extraction device activated by hydraulic trip hammers.
A. The cycle is carried out by the cylinder with the corresponding shoes holding.
B. During the phase in which the cylinders approach each other inside one cycle, the cylinders are held in accordance with the parameters of the cycle.
C. The conducted cylinder releases the retention of the shoes and moves into cycle-end position prior to the successive approach, and so forth and so on.

Key:
1. Cylinder 1
2. Cylinder 2
3. Cylinder 1 grasping shoes
4. Cylinder 2 grasping shoes
5. Sled
6. Grasping cylinder 1
7. Grasping cylinder 2
8. Device for adaptation to dimensions of bar
9. Bar
10. Work area of cylinder 1
11. Work area of cylinder 2
12. Locking and traction
13. Disconnection and waiting position
14. Cylinder 1 working
15. Approach of cylinders
16. Cylinder 2 working
17. Direction of extraction

Recent progess in horizontal continuous-casting processes, tied to the better understanding of the phenomena involved in the formation of the bar, led to the need for speeding up the extraction cycle and making it more exact; 240 cycles/min were achieved on an experimental basis.

The choice between the two extraction systems cannot be made in an entirely clear fashion. Engineers at Mannesmann consider the shoe system to be too cumbersome and therefore too expensive, considering the bar dimensions which are less than 50 mm, while they consider the multiple cylinder system to be disadvantageous for dimensions larger than 150 mm.

The cylinder system is currently the most frequently used system also for diameters of more than 150 mm while there is no industrial experience of equal breadth available for the shoe system; only the future will tell us whether it is destined to prevail in the new horizontal continuous-casting plants.

Secondary Cooling

Secondary cooling in horizontal continuous casting is connected with two different concepts concerning ingot molds:

use of relatively short ingot molds of 200-300 mm and graphite coolers;

use of a longer copper ingot mold of 400-500 mm and subsequent spray or two-phase cooling, similar to vertical continuous casting.

Studies with the help of models illustrating the growth of the shell in the secondary cooling zone revealed substantial similarity with vertical continuous casting; in the horizontal plant, the low ferrostatic pressure furthermore makes it possible to eliminate the upper guide rollers so that there is no longer any danger of bulging.

The Horicast plant of Fukuyama (22, 23, 24, 25) provides for a secondary cooling zone with a length of about 6 m, made up of six segments with separate control of water supply to the nozzles. In casting square sections of up to 120 mm, some builders do not consider any direct cooling to be necessary. The heat which the semifinished product loses due to irradiation and convection turns out to be enough and at the same time the bar temperature turns out to be maximum. This feature is a valid assumption for cold charging (Boschgotthardshuette plant) and direct rolling.

Instrumentation and Automation

The horizontal casting process cannot be observed directly; process control is based on adequate instrumentation. The temperature measurements of the ingot mold body, supplied by thermocouples placed near the break ring, are decisive for the purpose of judging the regularity of solidification; another procedure is based on extensimetric measurements made outside the copper ingot mold.

During normal operation, the temperature turns out to be low (for example, 160-240° C, Figure 15) (12); its pronounced drop indicates a cooling of the break ring and an excessive growth of the shell in keeping with the ring tied to the rupture of the shell with a possibility of interruption of the bar.

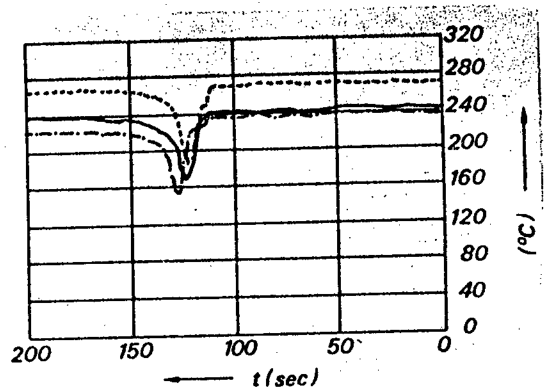


Figure 15. Progress of temperature as revealed by thermocouples placed in the ingot mold.

An unexpected drop of 20° C is indicative of rupture; the process is then stopped (manually or automatically) while the temperature drop can reach about 60° C; after several seconds of stopping, the temperature returns to the normal levels and extraction can be resumed (manually or automatically). The shorter the ingot mold, the briefer is the time which the operator has to decide to stop the process, to bring about a brief stoppage of the bar, and then to start up again.

In multiline machines, it is a good idea for installing a box dumper between the basket and the ingot mold so that the rupture in one of the lines will not make it necessary to close the entire plant down.

In high-quality steel casting it is particularly necessary to make sure that the extraction cycle is carried out with good precision. This made it necessary to perfect the blueprint for the operation of the holding rollers (pressure cylinders, electric motors, etc.). One uses special, continuous-current pair-motors coupled to the moving cylinder so as to bring about a transmission that will be absolutely free of any circumferential play (25).

A motor control system is shown in Figure 16. The continuous-current motor is controlled by a control unit which sends the corresponding pulses to the particular extraction program.

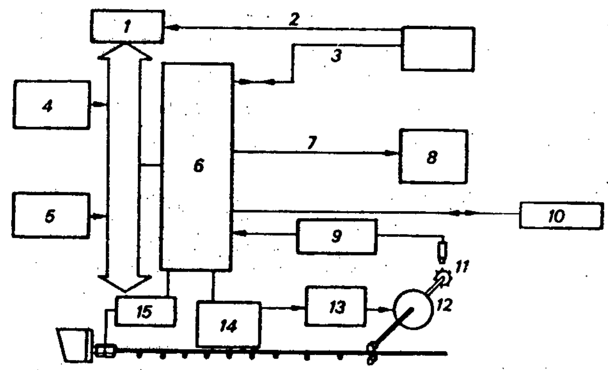


Figure 16. Horizontal continuous-casting process control system diagram.

Key:
1. Microprocessor
2. Speed selection
3. Control with feedback
4. ROM
5. RAM
6. Input-input [input-output] unit
7. Visual display
8. CRT
9. Monitoring of extraction step [pace]
10. Programming
11. Optical coder
12. Motor
13. Power amplifier
14. Analog-digital converter
15. Process control

Continuous-current operation is controlled by means of an optical coder connected to the idling cylinder; the signal, which is processed by a microprocessor, facilitates the comparison between the desired cycle and the actual cycle.

A horizontal machine, designed for casting a broad range of high-quality steels, requires complex programming of extraction cycles.

There are many studies which examine the quality features of the semifinished products deriving from the horizontal continuous-casting process. It must be kept in mind that the range of steels cast in horizontal machines either on an industrial scale or by way of experimentation is very broad and includes carbon steels for many different uses, structural steels, steels with a low, medium, and high alloy content (for tools and inoxidable items) and also some super alloys (24, 26-35).

In effect, any future extensive application of horizontal continuous casting is in general tied to the possibility of obtaining semifinished products of a quality that is at least equivalent to the one obtained from traditional procedures. The subject is rather vast and in the following paragraphs we will find a synthesis confined to the aspects that are considered most important.

Quality Features of Semifinished Products

Surface Features

The bar's surface quality is of fundamental importance to any comments on the quality of products obtained through hot-plastic working.

Observing a billet of horizontal continuous casting reveals a series of periodic linear traces placed at an interval that corresponds to roughly the extraction step. These traces (cold shut or primary oscillation traces) originate in the very solidification mechanism illustrated earlier and are tied to the adoption of discontinuous extraction.

In keeping with cold shut, we have a discontinuous crystallization structure which is 2-5 mm deep with different orientation of dendrites. Defects in the form of cracks emerge if, in the discontinuity regions, we do not achieve a good bond between newly-formed and old shells.

The problem of eliminating cracks due to cold shut was solved in the case of carbon steels while the same cannot be said in the case of highly-alloyed and inoxidable steels.

We might mention the following steps to diminish the oscillation traces and to reduce the tendency toward cracking:

increasing the extraction frequency,

decreasing the step between the break ring and the ingot mold,

optimization of characteristics of refractory material constituting the break ring,

adoption of electromagnetic beating in ingot mold,

raising the degree of overheating of liquid steel.

In the case of inoxidable and carbon steels, to prevent defects due to cold shut, the NKK Keihin adopted hot-grit-blasting (HSB = Hot Shot Blast) at the exit of the ingot mold (Figure 17) (36).

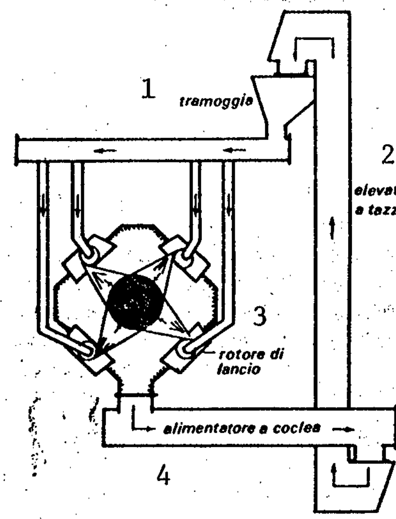


Figure 17. Hot shot blast plant.
Key: 1. Hopper
2. Bucket elevator
3. Starting rotor
4. Screw feeder

Internal Quality

Distribution of Inclusions

The level of purity of billets obtained through horizontal continuous casting can be compared to the level found in billets obtained in conventional continuous-casting plants.

The results naturally can be improved through treatment in ladle with activated wire, while the structure can be refined by adding Al to the basket. In this case, the inclusions assume a roundish shape and are barely detectable.

At 5-10 mm under the surface of the upper face of the billets, one can detect a tendency toward the densification of the inclusions.

This effect can be countered by bringing about an efficient hold between the ladle and the basket ($O_2 < 0.1$ percent).

Bar's Solidification Structure

The solidification structures of the bar deriving from horizontal continuous casting do not essentially differ from those obtained in the traditional plants.

Under normal casting conditions, columnar crystallization is present almost to the core; in this area, there can be coarse equi-axial crystals or disorderly dendrites.

Figure 18 shows the macrostructure of round billets with a diameter of 95 mm, consisting of low and high-alloy steels; in case of overheating to the extent of 40°, the minute crystallization that is typical of the columnar crystallization cover, extends all the way to the core. As in conventional machines, the solidification center is shifted toward the upper half (1-4 mm).

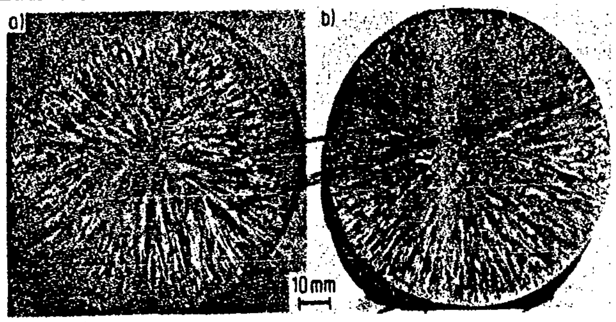


Figure 18. Macrostructure of round billets (diameter 95 mm). (a) High-alloy steels; (b) Low-alloy steels.

This asymmetry does not seem to have any major consequences; this was checked through rolling tests performed during the finishing phase of the production of seamless pipe from round billets as a result of horizontal continuous casting.

Central Porosity and Separation

In vertical continuous-casting plants, the quality of the central zone of the billet depends not only on the quality of the steel but is also influenced:

by the degree of overheating in the basket,

by the casting speed.

A roughly similar situation is encountered in the case of semifinished products obtained from horizontal continuous casting.

The horizontal continuous-casting process is characterized by low ferrostatic pressure especially at the end of the solidification crater. This peculiarity did not introduce any negative effects; the quality of the central zone of the horizontal continuous-casting bars is at the same level as that of similar semifinished products deriving from vertical continuous casting.

The larger diameter of the dumper, adopted for horizontal continuous casting, as compared to the traditional process permits a lower degree of overheating in the basket which, as in the case of vertical continuous casting, helps bring about better performance upon separation.

The adoption of electromagnetic beating, to improve the central porosity and separation, is also widespread in horizontal continuous casting. Various types of beaters (with rotating and linear field) have been tried out; their positioning (one or more units) is more flexible in the case of horizontal continuous casting as compared to conventional plants because the cylinders take up less space.

Some product lines necessitated specific improvements; this is true of steel for high-quality wires which requires an improvement of the structure at the center of the billet. EMS beaters were adopted for this product in the center and in the evacuation zone of the secondary cooling area.

In the first phase, EMS did not bring about an improvement of the structure at the core while an accumulation of globular crystals was found in the lower zone of the bar. It was possible to improve the quality by adjusting the casting speed so as to have a certain liquid-phase rate in the beating zone.

VOeEST-Alpine, in the horizontal continuous casting of special steels (37) on an experimental basis, is using a pulsating beater which, by means of timely switching, makes it possible to impart to the liquid steel certain additional oscillations at grid frequency which promote the redistribution of the dendrites. A further advantage deriving from this type of beater consists in the reduced formation of "bright strips."

The pulsating beater is mounted in pairs arranted in front of two opposing surfaces of the bar; in this way, the particular geometry of the field permits an increase in the radial component of that field.

In this way we get an improvement of the distribution of the crystals with positive effects on the globulitic crystallization fraction that can be detected on the section of the bar.

This is a concept which until now has prevailed in the magnetic beating of the secondary cooling zone of vertical machines in casting steels with a carbon content of up to 0.9 percent.

Recent Trends in the Horizontal Continuous-Casting Process

Plants for Semifinished Products with a Large Cross-Section

In 1983, the Keihin (NKK) steel mill installed a Horicast plant for large sections, capable of producing rounds up to 330 mm in order to develop the casting technology (38) for high-alloy and inoxidable steels in the form of semifinished products intended for pipes. The main characteristics of this plant are given in Table 4.

Table 4. Horizontal continuous steel casting plants in operation (excluding the USSR, 1985) (1) (2)

3 tipo	4 Boschgotthardshütte (Siegen) Technica, impianto industriale	4 Armco Inc. (Baltimore) Technica, impianto industriale	5 Thome Ind. (Paris) Wertli + progetto proprio impianto industriale	6 Krupp Stahl (Siegen) Krupp, impianto pilota	6 Chaperral (Dallas) SCE, impianto pilota	6 VEW (Kapfenberg) impianto pilota	4 Nippon Kokan (Keihin) impianto industriale	4 Seoul Steel (Inchon) impianto industriale	6 Kobe Steel (Takasago) impianto pilota	4 Sumitomo Metal Industries (Amagasaki) impianto industriale	6 Kawasaki Heavy Industries (Yashiyo) impianto pilota
avviamento 7	1980	1984	1976	1982 19	1984	1984	1983	1983	1981	1979 (?)	1982
dimensione paniera 8	7	7,5	4	1,3; 3 (oscillante)	30	2,5	5	2	3	0,6	3; 1,5
n. linee 9	1	2	3	1	1	1	2	1	1	1	1
dimensioni barra 10	150-200 ⌀	100-200□	26-70 ⌀	100□, 80-200 ⌀	130 x 175	100□, 110□	114-250□, 80-330 ⌀	100-180□, 180 ⌀	110-150□, 110-180 ⌀	147-328 ⌀	50-96 ⌀, 120□, 40 x 200
lunghezza macchina (totale) 11 m	40	55	n.b.	27	37	n.b.	70	55	20	30	32
lingottiera, mm 12	17 rame, 120	17 rame	17 rame, 600	17 rame, 300	17 rame, 100 + 18 raffreddatore, 200	17 rame	17 rame, 300 o 450 19	17 rame, 300 o 450 19	17 rame, 450	17 rame, 350	17 rame
anello di distacco 13	BN	BN	—	BN	BN	BN	Si_3N_4-BN sialon	Si_3N_4-BN	BN, Si_3N_4 + BN	sialon	BN
raffreddamento a valle della lingottiera 14	20 tubo di grafite 1100	21 piastre di grafite	20 tubo di grafite (presumibilmente) 22	23 H_2O polverizzata	24 1 piastra di rame + 2 piastre di grafite 3 x 600 21	21 piastre di grafite, 1000 H_2O polverizzata (sperimentale)	23 H_2O polverizzata 24	23 H_2O polverizzata	23 H_2O polverizzata	23 H_2O polverizzata	21 piastre di grafite
dispositivo di estrazione 15	25 motore a corrente continua 3 coppie di rulli e dispositivo a mascelle	26 motore a corrente continua 3 coppie di rulli		27 motore idraulico 2 coppie di rulli	28 motore a corrente continua 2 coppie di rulli	29 motore a corrente continua	30 motore idraulico 2 coppie di rulli 31	30 motore idraulico 2 coppie di rulli 31	32 motore a corrente continua 1 coppia di rulli	30 motore idraulico 2 coppie di rulli 31	28 motore a corrente continua 2 coppie di rulli
qualità di acciaio 16	acciai non legati mediolegati ed inossidabili 32	acciai inossidabili 33	acciai al Cr ledeburitici per sfere di macinazione 34	acciai al C, inossidabili, per utensili superleghe 35	acciaio a grana fine 36	acciai non legati e medio legati, acciai da costruzione, austenitici, ferritici, ledeburitici 37	acciai al C inossidabili 38	acciai al C e basso legati 39	acciai al C e inossidabili 40	acciai inossidabili 33	acciai basso legati, al carbonio e inossidabili 41

Key: (1) The plants considered here are actually in operation
(2) From K. Schwerdtfeger, STAHL U. EISEN [Steel and Iron], 106, no 1, 1986, pp 5-12
3. Type
4. Industrial plant
5. In-house project, industrial plant
6. Pilot plant
7. Start
8. Basket dimension
9. Number of lines
10. Bar dimensions
11. Machine length (total)
12. Ingot mold
13. Break ring
14. Cooling down-line from ingot mold
15. Extraction device
16. Steel grade
17. Copper
18. Cooler
19. Or
20. Graphite type
21. Graphite slabs
22. Presumably
23. Pulverized
24. Copper slab
25. Continuous-current motor, three pairs of rollers and jaw device
26. Continuous-current motor, three pairs of rollers
27. Hydraulic motor, two pairs of rollers
28. Continuous-current motor, two pairs of rollers
29. Continuous-current motor
30. Hydraulic motor
31. Two pairs of rollers
32. Continuous-current motor, one pair of rollers
33. Inoxidable steels
34. Cr ledeburitic steels for milling balls
35. C steels, inoxidable, for superalloy tools
36. Fine-grain steel
37. Nonalloyed and medium-alloyed steels, structural steels, austenitic, ferritic, ledeburitic
38. Inoxidable C steels
39. C and low-alloy steels
40. C and inoxidable steels
41. Low-alloy carbon and inoxidable steels

The achievement of good quality in the semifinished product, which is obtainable with a high extraction cycle frequency for large-section semifinished products and, therefore, in conjunction with a major extraction effort, required the perfection of the extraction control technique. In the case of inoxidable and nickel-alloy steels, the dilation coefficient and the hot-deformation resistance are high; this made it necessary to modify the conical shape of the ingot mold so as to contain the extraction effort within the mold.

The material for the break ring was improved to meet the most stringent conditions by adopting Sialon rings.

To eliminate surface defects (CSC = Cold Shut Cracks), a hot shot blast device was adopted down-line from the ingot mold. The increase in the dimensions made it necessary to adopt a metallurgical length of 40 m.

In relation to the increased extraction inertia, the operating project provided for four motor cylinders per line and one braking system.

In anticipation of a rapid dimension change in the bar, the ingot mold and secondary cooling were combined in a single complex so that it is possible to achieve the dimension change in 15-20 minutes per line. At the same time, the plant is equipped with moving cylinders and idling cylinders suitable for operating with rounds and billets of varying dimensions.

To improve the internal quality, the electromagnetic beater equipment was boosted.

Plants with Mobile Ingot Mold and Continuous Extraction

A pilot plant with oscillating ingot mold and continuous extraction was developed by Krupp Stahl A.G. [Inc.] in view of the impossibility of continuous casting, both in curved machines and in horizontal machines with fixed ingot mold, some grades of inoxidable steels and alloyed structural steels (39, 40).

The project which Krupp is developing calls for linear extraction of the bar; the ingot mold movement phase, which is known in connection with vertical continuous casting as negative strip, is expressed in the Krupp machine by a compression of the bar in the longitudinal direction.

Figure 19 shows methods of extraction (shifting the bar as a function of the time) in a Krupp horizontal continuous-casting plant with oscillating ingot mold and a cyclic extraction plant.

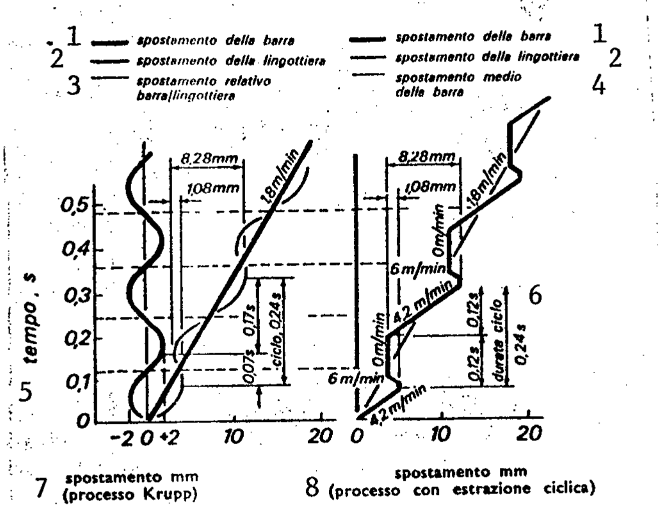


Figure 19. Movement of bar and ingot mold in various horizontal continuous-casting processes.

Key:
1. Shift of bars
2. Shift of ingot mold
3. Relative shift between bar and ingot mold
4. Average shift of bar
5. Time, sec
6. Duration of cycle
7. Shift, mm (Krupp process)
8. Shift, mm (process with cyclic extraction)

In the Krupp process, the oscillations of the ingot mold describe an extremely simple sinusoidal path; extraction takes place in a continuous manner at constant speed and, consequently, the blueprint for the extraction device also turns out to be simpler.

A cross-section of the plant is shown in Figure 20; basket and copper ingot mold connected to it vibrate by means of a vibrating table to which they are attached.

Here are some of the machine's features:

ingot mold length	500 mm
oscillation frequency (max)	7 Hz
oscillation amplitude	0.5–5 mm
extraction speed (max)	3 m/min
dimension of semifinished products	Ø 60–176 mm
	□ 100 mm
break ring	stabilized BN

An induction heater is attached to the basket; an electromagnetic beater, inserted in the form of a block in the ingot mold, is also provided here. The casting process is controlled automatically by means of a computer. It is considered possible that one can make a plant with two lines where the two ingot molds that are directly attached to the basket will oscillate by means of a sled.

The first experiments were conducted with standard inoxidable steels and special alloyed steels; these steels are cast with the Krupp process without any difficulty and without any need for subsequent surface treatment.

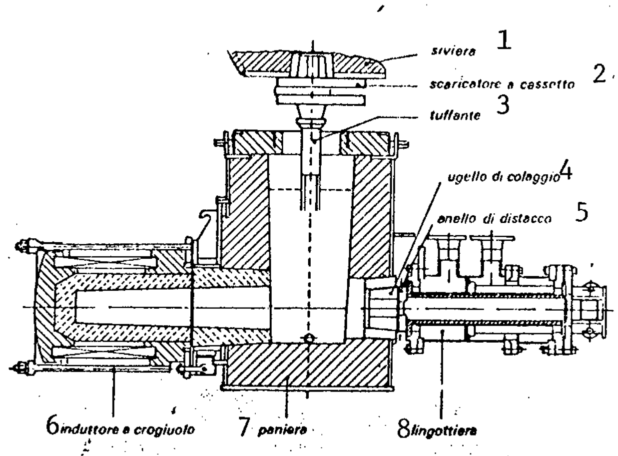


Figure 20. Horizontal continuous-casting plant with oscillating ingot mold, Krupp.

Key:
1. Ladle
2. Box dumper
3. Dipper
4. Casting nozzle
5. Break ring
6. Crucible inductor
7. Basket
8. Ingot mold

During the second phase, engineers began to cast high-alloy-content steels, for example, steels with 5 percent chrome (M 36 CrMoV 5 I), ferritic steels sensitive to cracks (X 20 CrNiTi 18 9), ferritic-austenitic steels (X 10 CrNi 30 9), and also heat-resistant steels (X 12 CrNi 25 20).

The results of the experiments were positive. Further steel casting tests were conducted for valves with a high alloy content, martensitic chrome steels (17 percent) and fast steels.

In 1983 it was announced that the Steel Industry Machinery Construction Experimental Institute in the USSR (41, 42) had built a horizontal-billet machine with bilateral linear extraction (Figure 2f).

As we can see, the cooled copper ingot mold is supplied to the center from a basket; while it oscillates horizontally toward the right and toward the left of its ends, two bars are extracted in a continuous manner in opposite directions.

The bar's extraction speed, the amplitude of the ingot mold at oscillation frequency--these in general are constant and are determined by the bar's cross-section and by the composition of the steel.

According to reports, the bilateral machine is capable of producing square, rectangular, and polygonal bars of 100-350 mm, supplying the liquid metal from the ladle of up to 150 t. The range of steels includes grades extending from structural steel to carbon steel, alloyed steels and inoxidable steels.

The bilateral procedure would appear to be also capable of casting flat bloom with a width-to-thickness ratio of 1:5 and a width of up to 1,000 mm. Since this procedure does not use the break ring, one would as a matter of fact have to consider that the road is clear to the production of semifinished products without any restrictions as to shape and dimensions.

But there are many points in this process which are not clear as yet so that it would be desirable to have further details, for example, (i) the mechanism and stability of the start of formation of the solidification shell in the absence of the break ring; (ii) surface and internal quality of semifinished product.

Concluding Remarks

About 20 years after the first casting experiments with fixed horizontal ingot mold, the horizontal continuous-casting process can be considered to have reached an advanced state of industrial use.

We can mention the following facts by way of confirmation:

existence of various processes (for example, Horicast, Technica Computocast) which work with results that have been declared to be industrially satisfactory and which are capable of casting a broad range of steels, from carbon steels to inoxidable steels.

In particular, we have seen the following:

an improvement in the surface and internal quality of the semifinished product; with respect to casting in ingots, the mechanical properties turn out to be equivalent while the degree of purity is also higher;

the achievement of a certain increase in the dimensions of the bar (rounds up to 330 mm) although with the help of less simple plant design solutions,

production runs without trouble and with good productivity levels.

New solutions are being studied for the purpose of:

increasing the range of cast steels to include high-alloy grades or steels that are particularly difficult to cast (Krupp process with oscillating ingot mold);

facilitate an increase in the bar's dimensions by overcoming the complications that make it necessary to shift large masses accurately (Mannesmann operation);

start multiline plants.

The most recent data (as of the end of 1984) reliably report the installation of 43 horizontal continuous-casting machines (64 lines) of which 26 are for wires, 37 for billets, and 1 for blooms), obviously an insignificant fraction of the total continuous-casting volume.

One may say however that the horizontal continuous-casting process has reached a degree of development making it practically useable both in the very small steel mills and in large-capacity establishments for the manufacture of small lots of specific grades. Table 4 summarizes the main characteristics of some of the horizontal continuous-casting plants currently in operation in the steel industry of the Western nations.

The adoption of the horizontal continuous-casting process will most likely depend on the following:

reorganization of existing continuous-casting plants (this is true of Japan where more than 90 percent of the steel is cast continuously and where plants have been operating for many years);

modernization of plants not yet equipped with continuous casting (the United States and, to a lesser extent, Europe);

the expansion of small steel mills, which is happening in the United States, for example.

The horizontal continuous-casting process could then make it possible to improve and differentiate the national output in those industrial countries which have small steel plants but which are in trouble now.

Tendencies and developments now in progress lead us to hope that the horizontal continuous-casting process will in the future most likely not be confined to billets and blooms. The possible affirmation of the Soviet bilateral bar extraction process could lead to developments which cannot as yet be easily anticipated. At the same time, development is continuing on more flexible slab casting processes which have not been examined in this article and whose success could still turn out to be profoundly innovative.

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5058
CSO: 3698/662

NOKIA COMPLETES LUXOR DEAL, BUYS STATE OWNED SHARES

Stockholm SVENSKA DAGBLADET in Swedish 8 Oct 86 Pt 3, p I

[Article by Uno Skold]

[Text] Luxor in Motala will be completely owned by the Nokia Concern of Finland. The Swedish state will sell its 30-percent interest in Luxor by delivering 20 percent to Nokia now and 10 percent later at a price that neither of the two sides wishes to disclose.

Luxor has operated at a loss since Nokia purchased 70 percent of the company in 1984. The first year Luxor lost almost 50 million kronor and during the first 8 months of this year the company has run a deficit of 100 million.

Nokia's interest in Luxor is based on the belief that there may be big profits to be made by coordinating the company's activities with those of Nokia's Finnish company Salora, according to Salora-Luxor's executive vice-president, Heikki Koskinen.

The Luxor factory in Motala has doubled its production of color TV sets since Nokia became the primary owner. There has been a concentration of production and Salora-Luxor has made a strong effort to grow in the field of industrial electronics. The production of microcomputers has been a disappointment, however, because of the sharp decline in the market.

Overall, Salora-Luxor is making a profit. Several of its divisions are profitable. Nokia has not yet made a prediction of this year's results and says it is difficult to make any calculations, since the sale of consumer electronics is so highly concentrated in the final months of the year.

Luxor's results were even worse through August of this year, since the personal computer market has become stagnant. Now Luxor is attempting to develop its profitable programs and restructure its organization.

Salora-Luxor is the largest Nordic manufacturer of consumer electronics. According to management, operations at the Motala plant will continue at the present pace and no layoffs will be made.

Undersecretary Olof Rydh of the Industry Ministry said that Motala's need for new equity capital made the government decide to sell out now.

"On the other hand, it was a natural development. Even back in 1984 it was clear that Nokia would take over the remaining 30 percent and it was now their turn to take over the chairmanship," Olof Rydh told TT (TIDNINGARNAS TELEGRAMBYRA).

In his comments on the sale, Industry Minister Thage G. Peterson said it would give Motala employees the greatest possible security. He said the government believed that the most important aspect of the sale had been that Luxor would be given a good chance of continuing to develop within the fields in which it had been most successful.

9336
CSO: 3698/41

BRIEFS

PHILIPS IN NEW ESPRIT PROJECTS--Eindhoven, 17 Oct--Dutch electronics multinational Philips said today it will participate in four new projects in the third round of the European Community's information technology research and development programme ESPRIT. Philips is now involved in a total of 35 ESPRIT projects. Three of the new projects are in the area of computer software and the fourth is concerned with computer-aided manufacturing (CAM), it said. The new projects would run for an average of three years each and work will be conducted at Philips Laboratories in Britain, France, the Netherlands, and West Germany, it added. The combined budget for the four projects is 50 million guilders. [Text] [The Hague ANP NEWS BULLETIN in English 17 Oct 86 p 3] /9274

CSO: 3698/068

UK RESEARCH COUNCILS URGE INCREASED R&D FUNDS

London SCIENCE AND PUBLIC EXPENDITURE 1986 in English 86 pp 1-25

[A report to the Secretary of State for Education and Science from the Advisory Board for the Research Councils; date of publication not indicated]

[Text]

THE ADVISORY BOARD FOR THE RESEARCH COUNCILS was established by the Secretary of State for Education and Science in 1972 with the following terms of reference:-

a) To advise the Secretary of State on his responsibilities for civil science with particular reference to the Research Council system, its articulation with the universities and departments, the support of postgraduate students and the proper balance between international and national scientific activity;

b) To advise the Secretary of State on the allocation of the Science Budget amongst the Research Councils and other bodies, taking into account funds paid to them by customer departments and the purposes to which such funds are devoted;

c) To promote close liaison between Councils and the users of their research.

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Professor Sir David Phillips, FRS (Chairman)	- Professor of Molecular Biophysics University of Oxford
Professor R L Bell	- Director-General of ADAS Ministry of Agriculture, Fisheries and Food
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Sir Douglas Hague, CBE	- Chairman, Economic and Social Research Council
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Professor P Mathias, CBE, FBA	- Chichele Professor of Economic History, University of Oxford
Dr J Metters	- Deputy Chief Scientist, Research Management Division, Department of Health and Social Security
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SECRETARY

Mrs H M Williams

The Rt Hon Sir Keith Joseph Bt MP

28 April 1986

DEAR SECRETARY OF STATE

PUBLIC EXPENDITURE SURVEY 1986
ADVICE FROM THE ABRC

1. At the outset of each year's public expenditure survey the Board submits advice on the financial position of the Science Budget. This year's advice is attached.

2. In successive submissions the Board has expressed its concern at the financial pressures on the science base implied by the Government's expenditure plans. Although some relief has been offered in successive public expenditure settlements, the additions have not been adequate to check the steady erosion of purchasing power. The prospect for the science base on current expenditure plans is thus one of steady decline in both the scale and quality of the research that can be sustained.

3. At the same time, the demands made on the science base are growing. There are industrial demands, with signs of growing concern among senior industrialists

that the continued erosion of the science base, which they see as vital for their needs and a clear responsibility of Government to maintain, will seriously harm their future. There are social demands, such as the need to do something about AIDS. The scope for the Research Councils to match scientific opportunities to these national needs, especially economic needs, has never been greater: across the whole spectrum of research conceptual advances and the availability of new techniques have opened up new fields of enquiry with enormous potential for practical application - notably the new science-based technologies which hold the prospect of revitalising existing industries and launching new ones.

4. The Research Councils have made an exceptional response to the challenge which these opportunities offer. Resources have been redeployed into new growth areas on a considerable scale. The decisiveness with which Councils have reshaped their programmes and the scale of the upheaval involved must be without parallel anywhere in the public or private sector: over 3,000 posts will have been shed this decade in two Councils alone, representing 30% of their manpower.

5. But despite these efforts, the overall constraints on the Councils make it impossible for them to match the international competition in the scale of their investment, even allowing for much greater selectivity than hitherto. The pace of scientific investment is set internationally: if we lag too far behind, more of our talented scientists will leave us while those who stay here become increasingly demoralised and out of touch with developments at the frontiers of their fields. Councils' evidence to the ABRC plainly conveys their sense of national loss at not being able to fund to international standards the talent that exists in this country. On the ground the morale of the scientific community has never been lower.

6. Last year we recommended that you bid for an increase of a cumulative 2%-2.5% in the then expenditure plans for the Science Budget. The outcome of the settlement was a simple 2.5% addition in 1986-87. This year our bid is for increases of £35m (5%) in 1987-88; £50m (8%) in 1988-89 and £60m (10%) in 1989-90 plus whatever may be necessary to compensate SERC for the unforeseen increase in the cost of its international subscriptions (£9m at the latest reckoning).

There are two essential reasons for the increase in our bid over last year's:

i) last year the Board's bid represented a halving of the total of bodies' claims. Our moderation of their claims was largely arbitrary, reflecting our view of what it would be realistic to bid for, given the Government's overall public expenditure policy. We did not feel that we could similarly moderate their claims this year, such was the concern expressed to us about the cumulative effect of the pressures of recent years on the strength of the science base;

ii) our conviction of the positive case for increasing the nation's investment in science. The Research Councils are making a tremendous effort to meet national needs: the relatively small injection of additional funds which our bid represents would enable them to develop properly the programmes described in section 5 of our advice; including programmes of great potential for the future international competitiveness of British industry.

7. I look forward to discussing the Board's analysis and recommendations with you, if you would find that helpful. I hope you will be ready to agree to publication of the advice, in due course.

DAVID PHILLIPS

1986 PUBLIC EXPENDITURE SURVEY: ADVICE OF THE ADVISORY BOARD FOR THE RESEARCH COUNCILS

1. Introduction

1.1 This submission presents the Board's annual advice to the Secretary of State on the implications of the Government's expenditure plans for science, with particular reference to the Science Budget. The Science Budget - some £580m in 1985-86 - goes mainly as grant in aid to the 5 Research Councils which support civil scientific research in higher education and in their institutes; and related postgraduate education. Although the Science Budget is the principal focus of this submission, the Board has necessarily had regard to the general support of research activity in universities from UGC funds which represents the other limb of the dual support system, complemented by specific support of research projects and programmes through the Science Budget. Taken together the activities supported through the Science Budget and through the UGC comprise what is conventionally known as the civil science base.

1.2 The Board's last submission to the Secretary of State - "Science Budget Allocations 1986-87 and Planning Figures 1987-88 to 1989-90" - advised on the distribution between Science Budget bodies of the £15m baseline addition to the then expenditure plans which emerged from last year's public expenditure settlement. On that occasion the Board welcomed the new money but expressed concern that it would not be sufficient to check the continuing erosion of the real value of the Science Budget.

1.3 Picking up from this point, the present submission surveys the nation's expectations of the science base; and considers how far the Research Councils generally are responding to those expectations within present financial limits, as a basis for reviewing their claims for additional funds. **The Board's bid in the light of this appraisal is for a minimum increase over present Science Budget planning figures of £35m (5%) in 1987-88; of £50m (8%) in 1988-89 and £60m (10%) in 1989-90. Additionally we bid that SERC be compensated for the effect of recent exchange rate movements on the cost of its international subscriptions. The effect has been to increase these costs by £9m in 1987-88: without compensation this can only be found by further reductions in the Council's support for science.**

2. Growing Demands on the Science Base

2.1 Scientific research in the Research Councils and in higher education is supported from public funds because it meets national needs. As we pointed out in the advice we submitted this time last year "the origins of the present Research Council system largely go back to war time - 1915 - and the concern of the then Government to harness scientific research to serve practical goals in defence, industry, medicine and social welfare". The belief that the Research Councils are primarily concerned with supporting pure research solely for its own sake reflects a widely held misconception about their role. **In fact the Councils support research primarily <u>because</u> of its ultimate relevance to national needs:** the needs of business for technological development to maintain its international competitiveness; and the need for solutions to practical problems - environmental, medical, social - in all sectors of the economy. Some of the work supported by the Councils is obviously relevant to national needs - in the sense that there is a generally agreed prospect of applications in the foreseeable future. But the support of research and research training which is not so obviously relevant - where the objective is to advance knowledge without any clear idea of where it will lead - is just as important in providing the basis - knowledge and skills - for more focussed work in the future.

2.2 The Board's perception is that **the national needs which the science base exists to meet have become more pressing in recent years; and that these pressures are growing.** In large part, the pressures come from industry. The contribution of the science base to the introduction of new, and development of existing, industrial technologies is well recognised. What is less well appreciated is that we are in a phase when industry's expectations of the science base have increased and are continuing to increase. The background to this phenomenon, which is manifest throughout the developed economies of the west, is that the industries which helped to foster the post-World War II economic upswing - cars, electronics, consumer "white goods", semi conductors, aerospace, pharmaceuticals and petrochemicals - are now in a mature phase. Against this background, industry and national Governments throughout the developed world are seeking to develop new core or "generic" technologies which offer the promise of revitalising old industries and launching new ones to cater for new markets.

2.3 The new generic technologies - for example, biotechnology and information technology - are science based, that is to say their development is crucially dependent on further advances in basic research and related training. To this extent, the science base has a vital role to play in helping British industry maintain and enhance its technological competitiveness against the rest of the world. **Concern about the already weak and arguably deteriorating competitive position of British industry increases the pressure on the science base to do its part.**

2.4 There is considerable evidence that British industry, for its part, recognises the increasing importance of closer interaction with the science base, if it is to hold its own in international markets. There are, for example, recent instances of British companies recruiting leading academic scientists, in some cases complete with their entire research teams. The volume of research undertaken collaboratively between industry and the Research Councils and higher education has grown. The volume of research which industry commissions from the science base has also grown. Industry's appreciation of its growing dependence on science was also apparent in the contributions to the Secretary of State's July 1985 seminar with industrialists.

2.5 British industry is not unique in this respect. As we have already noted, increasing industrial interest in the technological potential of scientific research is a feature of the developed world as a whole. It is often remarked that foreign-owned companies are at least as actively engaged as their British couterparts in seeking out talent and ideas on our university campuses. The national Governments of our economic competitors are equally engaged in the race to develop new industrial technologies. This increases the pressures on our science base because the publicly funded investment in science of our major economic competitors appears to have increased relative to ours - in some cases very significantly. **The brain drain from the UK which we documented last year is symptomatic of the failure of our investment to keep up with that of our competitors,** since scientists operate in an international market and tend to go where the best opportunities for pursuing their particular line of research exist. In this connection the Board has now seen the preliminary findings of a study which we commissioned from the Science Policy Research Unit at Sussex University of comparative public support for the science base in the USA, UK, Japan, West Germany, France and the Netherlands. The UK's per capita expenditure emerges as the lowest of all the countries studied: the UK's expenditure on its science base is also lower than all its European competitors as a percentage of GDP.

2.6 The growing dependence of the international competitiveness of UK industry on academic research puts tremendous pressure on the science base. It must seek to promote areas of research perceived as having technological potential, where the scale of investment needed is determined by the pace set by our competitors. At the same time the science base must sustain fundamental work, where there is as yet no prospect of applications, because of the likelihood that potential applications will ultimately emerge. Wherever possible the scientific community seeks to undertake research and related training in collaboration with British industry, but to the extent that the work is fundamental and the specific outcomes uncertain, industry cannot be expected to contribute significantly towards the cost.

2.7 Pressures from industry on the Research Council system mainly impact on SERC and AFRC. But other Councils have likewise been subject to pressure from "their" sectors in the national economy. Society's aspirations, as articulated in Government policies - for example for better health and a cleaner environment at reasonable cost - depend in the shorter or longer term for their achievement on research undertaken by the science base.

2.8 The Board is the first to recognise that, while science grows rapidly, reflecting its own internal dynamic as well as the stimulus of national needs and international competition, national wealth and the resources that are thereby available from the public purse to support science do not grow at anything like the same rate. This means that the scientific community must be prepared to be more selective in its support, concentrating resources on fields where national needs are particularly pressing or where there is a strong prospect of significant returns. This kind of selectivity is increasingly being exercised within the science base: closer attention to priorities, management and value for money are at the heart of the Councils' response to the growth in the demands made of them. The following section of this submission gives more detail.

3. The Response of the Science Base

AFRC

3.1 Between 1983 and 1989-90 the AFRC will shed 2,000 posts (30%) in the course of accommodating reductions of 18% in its Science Budget allocation and of 20% in its commissioned research income. The Council is also drawing together its 24 institutes into 8 new institutes, each under a Director of Research, so as to achieve stronger central management. At the same time AFRC is reshaping its whole programme: traditionally the major pressure from the agricultural industry had been to increase production. With the emergence within the EEC of surpluses, the emphasis now is on minimising inputs (land, agrochemicals etc) so as to reduce unit costs and maintain the competitive position of British agriculture; and on devising alternative uses, both of land and of agricultural products. The Council is also building up its food research programme in response to the need - articulated by ACARD among others - for more basic work in this economically important area. The reorientation of AFRC's programme - many of its more traditional lines of research have been cut in order to reflect the changes in demand from the agriculture and food industries - is also a response to recent rapid advances in biological research which open up new opportunities of considerable potential for agriculture and food processing.

ESRC

3.2 The ESRC has restructured its committees into inter-disciplinary boards leading to savings of £100,000 a year; and is reviewing the scope of their programmes. **The Council is committed to increasing selectivity by promoting centres of excellence;** and has taken decisive action through sanctions, to improve PhD submission rates. **The theme of "Change in Contemporary Britain" has formed a major focus of ESRC's research programme since 1984, in recognition of the profound changes that are affecting social and economic aspects of British life, and the importance of adapting to change for our future prosperity.** Within this framework the Council is promoting, for example, research into the changing structure of economic activity; the implications of new technology and its use in organisations; the functioning of markets; the attitudes of the population to changing employment patterns and the ways in which people adapt to these; job generation; the social causes of drug addiction; and science policy studies.

3.3 ESRC report rapid developments in the social sciences with increasing use of large scale data sets (eg census data, election studies) which plot social change over time and make it possible to escape from traditional disciplines and examine subjects in depth and across boundaries.

MRC

3.4 The MRC has closed 23 of their Units over the past 10 years reflecting increasingly strict management: new needs in MRC's existing programmes are being met entirely by redeployment; redeployment is additionally contributing to the cost of new MRC initiatives. **The Health Departments and the National Health Service are the main customer of the MRC, on which they depend for biomedical, clinical and health services research.** Social needs and demographic change have been reflected in the research which the MRC has mounted in response to the AIDS epidemic, to the increasing size of the elderly population and to the growing problem of drug addiction. The Council is also seeking to foster clinical research, an area which has been adversely affected by funding constraints on the NHS and the universities: the Council has already introduced a scheme of clinical research professorships and readerships and is committed to introducing a new fellowship scheme that is more specifically tailored to the needs of clinical research workers. **The close connection between research and clinical practice is exemplified in a number of major new programmes most notably in molecular medicine (the clinical application of molecular biology), neurobiology and nuclear magnetic resonance imaging.**

3.5 While the MRC's principal links are with the NHS, it has recognised the potential for industry - drugs, medical equipment etc - to benefit from its research. Celltech has exploited and marketed a number of products derived from MRC work. The Council has now established a Centre for Collaborative Research which will provide a service for analysing problems and will channel advice and expertise to industrial, academic and clinical interests; and will sponsor collaborative projects in biotechnology and health care.

NERC

3.6. **To make room for new work and to reflect the increasing capital-intensity of the science it supports, NERC is substantially reducing its directly employed manpower: over 1,000 posts are to go between 1981 and 1991-92, representing a reduction of 33%.** NERC has introduced stronger central management: henceforward the programmes of its 13 institutes will be centrally managed under 3 new Directors of Science. NERC has achieved its objective of increasing the proportion of its income from commissioned research to 30%; and has succeeded in broadening its customer base. **At the same time the Council is seeking to respond to a surge of interest in the environmental sciences** - reflecting a heightened perception of the economic and social importance of environmental management - and to a surge of new scientific opportunities, partly reflecting the availability of new techniques of data acquisition.

SERC

3.7 **Over the last decade SERC has achieved a very significant shift in the balance of its programmes in response to industry's needs.** Notably the proportion of SERC's budget spent on engineering research has more than doubled: it now accounts for 30% of the total budget. The programmes of the Council's Science Board are similarly being re-oriented, to give higher priority to the "strategic" research needed to underpin the development of new technologies. **This redeployment into strategic research has been and is being achieved at the expense of other programmes:** in the past 10 years the Council's astronomy, space and nuclear physics expenditure has dropped from over 60% of its budget to less than 40% - and further reductions are planned. **An important part of SERC's response to industry's needs has been development of novel forms of collaboration with industry.** Examples of its efforts in this area are the establishment of Directorates in strategic areas (eg Biotechnology and Application of Computer Technology in Manufacturing Industry) and the highly successful Teaching Company, ASE and Cooperative Research Grant Schemes.

4. Finance

4.1 The preceding paragraphs have briefly described the substantial amount of activity aimed at securing the better management and more effective deployment of the funds available within the Science Budget in response to changes in national needs. There is more to be done in this direction: the Board considers that the Research Councils should continue to increase their flexibility, by which we mean the capability within level or declining budgets for response to new demands. We are also concerned that Councils may not yet have fully addressed the implications for them of more selective support of UGC-funded research; and have worries about the effectiveness of inter-Council collaboration, particularly in the broad area of biology, which straddles a number of Council boundaries. But we do not accept that better management of itself can offset the financial pressures on Science Budget bodies. Better management is about the more effective deployment of available funds: **it cannot be and is not a substitute for adequate funding overall.**

4.2 **There is mounting evidence that the cumulative financial pressures on Science Budget bodies have reached the point where the health of the science base is already seriously affected and further seriously threatened.** The Board is aware that in terms of the GDP deflator the value of the Science Budget appears to have held up well over recent years. However the GDP deflator reflects only average inflation and fails to acknowledge any of the following factors:

i) the tendency of scientific equipment and materials costs is to rise at rates exceeding average inflation, reflecting the increasing capital-intensity of science and the availability in already capital-intensive fields of more sophisticated techniques and apparatus;

ii) the Research Councils are incurring redundancy and other restructuring costs;

iii) there have been significant increases in the real cost over the period of international subscriptions (which account for over 10% of the Science Budget) due both to adverse exchange movements and to rises in the UK's relative GNP (where subscriptions are GNP-related);

iv) in contrast to Government departments which have their superannuation payments met centrally, the Research Councils have to meet annual increases in their bills for employees' superannuation which exceed average inflation.

4.3 Moreover, simple comparisons of the total Science Budget over time need to take into account the earmarking of certain additions - notably for the British Antarctic Survey and for information technology. Such additions increase the resources available in real terms but by reason of their earmarking do not increase Councils' capacity to switch resources into new fields.

4.4 We estimate that after allowing for the "relative price effect" of superannuation, restructuring and international subscription costs; and after allowing for the year on year real increase in equipment and materials costs associated with increased capital-intensity and sophistication, **the real value of the Science Budget, in terms of the volume of research that can be funded, will fall by more than 10% over the 1980s as a whole, on current Government expenditure plans.** If we additionally allow for the earmarking of programmes and the pressures of national needs, international competition and the wealth of new opportunities, the dimensions of the financial crisis with which the Science Budget bodies are trying to cope become apparent.

4.5 The strains on the system are manifest in a variety of ways including:

i) in recent years both the number and value of research grant applications have increased, primarily in just those strategic areas where a boost in funding would be expected to lead to developments of interest to industry. However, the percentage of top quality (alpha-rated) research grant applications from the scientific community that Councils are able to fund has fallen, despite the priority which Councils have given to this mode of support;

ii) the Board's "brain drain" survey last summer showed how talented scientists were being "poached" by overseas universities and industrial companies; and that gifted graduates in this country were increasingly turning away from scientific careers because of the perceived poor prospects;

iii) there is widespread concern about the under-capitalisation of the science base. Industrialists who attended the Secretary of State's seminar in July 1985 expressed their concern at the equipment shortages they perceived in British universities;

iv) there is evidence that the UK has fallen behind the international competition in a number of key fields;

v) there is a serious crisis of morale in the scientific community arising from dismay at the effects on the ground of the Government's science expenditure policies.

4.6 This submission is about the financial position of the Science Budget, not of the dual support system as a whole. We cannot ignore, however, trends in the support of research from general university funds, since this provides the basis on which Councils' specific support builds. We can only endorse the grave concern which the UGC express about the effects of the Government's expenditure policies on the general research base, which depends on a sufficiency of equipment, materials and support staff, especially technicians; and on an adequate level of academic staff time. In this latter connection, we note with particular concern the worsening of university academic staff-student ratios in science over the last few years and the further worsening that is in prospect on current expenditure plans.

5. Quantification of Need

5.1 The Board has given detailed consideration to the financial position of each of the Science Budget-funded bodies. **Our scrutiny indicates a considerable and widening gap between the Government's plans for the Science Budget and the minimum provision which bodies consider is necessary if national needs are to be met.** Bodies emphasised that in each case their assessment of the gap was tempered for realism and related to clearly defined economic and social needs: it was not based on the unconstrained aspirations of the scientific community. The total of bodies' claims on this basis amounted to some £35m (5%) in 1987-88 rising to £50m (8%) in 1988-89 and £60m (10%) in 1989-90.

5.2 Last year the Board advised the Secretary of State to bid in the public expenditure survey for an uplift in the then Science Budget planning figures of between 2% and 2.5% per annum. In so doing we had deliberately and to an extent arbitrarily moderated the full claims of bodies which amounted to more than double our final bid. We did this in the interest of realism, mindful of the Government's overall spending policy. Bodies' total claims this year amount to about the same as their claims last year. Again we have pressed bodies hard on the justification for their stated claims. The justification which emerged from the interviews and associated discussions related to the <u>cumulative</u> effect of budgetary pressures coupled with the increasing demands described in sections 2 and 3 of this submission. Bodies' perception is that the Government's expenditure plans imply that <u>new</u> savings in volume have to be identified each year. Although the scope for <u>efficiency</u> savings has been exploited, increasingly, savings have had to be found by cutting support for scientific programmes.

Equipment

5.3 Economies have commonly been made on equipment and materials budgets because savings here can be made directly and quickly without incurring the penalty of the restructuring costs which arise when staff are shed and laboratories merged. But while economies in equipment and materials may be a useful one-off expedient, if they are not quickly restored, scientists' ability to undertake worthwhile research is permanently impaired. Indeed all the pressures on Research Councils are to increase their spending on equipment (see paragraph 4.2 (i) above).

5.4 Concern about under-funding of equipment and materials runs through Councils' Corporate Plans and their submissions to the Board. On the one hand Councils' own establishments are short of funds to replace outworn and obsolete equipment and to acquire the equipment needed for new programmes. On the other hand Councils have pared down the allowances they make for equipment and research grants to scientists and higher education: their aim in so doing has been to spread the available money as widely as possible in the scientific community. Had they not done so, the acceptance rate of alpha-rated research grant applications would have fallen further and more research teams would have been broken up, for lack of support. It is obvious, however, that this policy cannot be sustained in the longer term without producing a serious imbalance of human and capital resurces.

5.5 **One set of bids from Councils accordingly relates to the urgent need to restore equipment budgets both in their own institutes and in their direct support of research in higher education.** AFRC, NERC, MRC and SERC have all singled out equipment shortages as demanding urgent remedy. Some of the additional money allocated last year was used to alleviate equipment shortages but the problem demands a more sustained effort. The largest single claim under this head comes from SERC which bids for £40m over the 3 years of the survey period for re-equipping university groups supported by its Science Board. SERC have said that its other Boards may submit similar bids in due course. The Science Board bid relates exclusively to equipment which the Council would usually expect to provide to leading university research teams. The items concerned (costing £50,000 each and upwards) would not normally be provided from general university funds and they are accordingly complementary to the 'stock' items which feature in the separate equipment bid which the UGC is putting forward. SERC's proposals similarly complement and extent the special UGC equipment grants scheme, which aims to re-equip a few departments, representing all fields of science and engineering, on a highly selective basis.

5.6 In scrutinising the claims related to equipment, we were conscious that a realistic response to the problem, given increasing capital intensity, must include more selective allocation of the resources available. We were generally reassured that Councils accepted this: for example the MRC in their Corporate Plan acknowledge that in order to reflect scientists' increasing needs for expensive and sophisticated equipment "whatever the financial situation a concentration of resources and certain disciplines will be essential in selected areas". **Collectively bodies' equipment bids already assume that greater selectivity than hitherto will be exercised in the allocation of resources.**

Scientific Opportunities and National Needs

5.7 Earlier sections of this submission have described the growth of scientific opportunities and of the external pressures which stimulate and interact with scientific development. We have also described the response of the Councils who have cut programmes and manpower and redeployed resources, at the cost of a considerable internal upheaval, into support of the new priorities. But there are limits to how far they can go in this direction within budgets that are falling in real terms or, at best, stable. **Councils' evidence plainly conveys the sense of national loss they feel at not being**

able to fund adequately the talent available in this country to develop key fields; and at falling so short of the investment made in competitor countries.

5.8 The AFRC estimate that they should be investing an additional £4m per annum in the important new biological programmes which they have been constrained to launch on only a very modest basis. NERC have bid for an additional £2-3m per annum for fostering environmental science particularly in rapidly developing fields such as atmospheric chemistry. NERC also expressed general concern that the amount of basic and strategic research they can continue to support, on present plans, will become increasingly inadequate to underpin the applied contract work on which their institutes depend, on average, for 40% of their income.

5.9 The MRC estimate that they need a global addition of £5m in 1987-88 rising to £10m in 1989-90 in order to foster the talent available in growth areas such as molecular medicine and neuroscience and to help raise the quality and quantity of clinical research. SERC has bid for an addition of £6m in 1987-88 rising to £16m in 1989-90 for investment in "major growth points" in engineering and in strategic science. Among the "clear examples" which the SERC quote of "work which will be inadequately funded in relation to reasonable objectives, even assuming some benefits from internal redistribution" are: the application of computers in engineering design, processes and manufacture; optical computers; separation and purification processes; molecular electronics and low dimensional structures and devices; materials science; biological and chemical sensors; and molecular recognition and protein engineering. These are all areas of enormous interest to industry. Within current plans, some are being funded, but at sub-optimal levels; some have barely got off the ground.

The Bids

5.10 The aggregate of bodies' bids, as outlined in paragraphs 5.3 to 5.9, broadly breaks down between equipment on the one hand and scientific opportunities on the other as follows:

			£m cash
	1987-88	1988-89	1989-90
Equipment	15	20	25
Growth areas	20	30	35
	35	50	60

Although we have not specified their needs here, these figures **also take some account** of claims from smaller Science Budget bodies notably **the BM(NH)** in relation to its services to the scientific community and its wider educational role in science; and **the Royal Society** in relation to its valued non-tenured university research fellowship scheme.

International Subscriptions

5.11 The figures in paragraph 5.10 do not, however, take any account of the sharp increase which the SERC is facing in the costs of their international subscriptions reflecting the fall in the value of the £ against European currencies and the relative movement of the UK's GNP. **These factors present SERC with a bill for additional costs in relation to its international subscriptions which at present stands at £9m in 1987-88.** Professor Mitchell has written directly to the Secretary of State about this unforeseeable cost increase which cuts savagely across the Council's attempts to plan its expenditure effectively. We share his view that the measures so far offered by Government are inadequate; and that the problem these factors present for the Science Budget should be urgently addressed by Government with the Board and SERC.

Until they are solved we see no alternative but to recommend an additional bid in this year's survey for the science that would otherwise be lost.

Restructuring

5.12 We use the term "restructuring" to denote the reorganisation of physical and manpower resources to achieve one or more of a number of objectives including

- greater concentration of provision in a few well-resourced centres of excellence

- closer proximity and thereby better integration between groups in related fields (for example groups in Research Council institutes and related university research groups; or groups engaged in research and the potential users of that research);

- the redeployment of resources from lower priority to higher priority fields which may involve staff redundancy and relocation costs.

5.13 The financial pressures of recent years have provided an impetus for restructuring, particularly for the AFRC and NERC which have traditionally been largely institute-based and which have suffered significant reductions in their income from commissioned research. But the Board's view is that restructuring should not be regarded just as an emergency response to financial crises. Whatever the overall financial situation the matching of the pattern of resources to changing needs and priorities should be a continuing activity throughout the Research Council system. **The present planning figures for the Science Budget, however, allow no headroom for this kind of reorganisation which may have high costs in the short term, but would lead to benefits in the longer term.**

5.14 The MRC has given us notice of a potential restructuring bid relating to the future of the Clinical Research Centre (CRC). It has accepted the recommendations of an independent committee that, to strengthen clinical research in this country, it is necessary to create a single centre for postgraduate medical education and research; and that this should be established by merging the CRC and the Royal Postgraduate Medical School, Hammersmith on one site, with basic medical science as an integral part of the new institution. MRC is now considering, with interested parties, the feasibility of setting up the new centre; and its optimal siting.

The costs of the merger are likely to be considerable. If the outcome is a decision to press ahead with the merger, MRC will thus be seeking the Secretary of State's approval and entering a substantial additional bid against Science Budget funds. At this stage however it would be premature to make any estimate of the scale of the claim **and the Board's bid, presented below, accordingly makes no allowance for it.**

6. Conclusion

6.1 **Our recommendation in relation to the Science Budget is for an increase over present planning figures of £35m in 1987-88 rising to £50m in 1988-89 and £60m in 1989-90 PLUS whatever is needed (some £9m at the latest reckoning) to compensate SERC for the recent increase in the costs of its international subscriptions.** These sums would just about be sufficient to restore the real value of the Science Budget to its 1980 level. We are putting this bid forward as the **minimum** increase necessary to put the Science Budget in a position adequately to respond to national needs. We urge the Government to regard meeting the bid as a necessary **investment** which should yield substantial returns.

6.2 We understand that the Government's policy is to maintain and enhance the strength and quality of the science base; and acknowledge gratefully the additions to planned Science Budget expenditure that have emerged from successive public expenditure surveys, notably the baseline addition of £15m from the 1985 survey. But these additions have not been on a scale sufficient to arrest, still less to reverse, the progressive erosion of the funding of the science base both through the Science Budget and through the UGC. **We believe that the time has come for the Government to consider seriously the long-term effects of its expenditure policies; and the need for a policy for the science base that states the Government's longer-term aims and intentions more clearly than can be inferred from year on year public expenditure decisions.**

6.3 The long-term prospect for the science base on present expenditure trends is one of steady decline. **Present trends imply that by 1990 the volume of research supported through the Science Budget alone will be some 10% less than at the beginning of the 1980s. There may well be a still greater decrease in support for research through the UGC.** The Board views this prospect with dismay. There is a striking contrast between it and the growing economic and social pressures to which the science base must attempt to respond. We cannot assume that the growing gap between the capability of the science base and national needs will be closed even partly by private funds. Our recently completed study, of the scope for extending private funding of research found that, for sound commercial reasons, industry is not prepared to commit its funds to the speculative, pre-competitive research which the science base exists to support. Although there is scope for an expansion of collaborative research with industry in strategic areas where applications are in sight, **our study found that increased publicly-funded investment is the essential pre-condition for engaging more private sector funds through collaborative programmes.**

6.4 Perhaps the Government envisages, as a matter of policy, the maintenance of quality at the expense of scale, leading to a publicly funded science base smaller than at present - in the number of research workers employed and the number of laboratories maintained. If this is the Government's intention we must insist that provision should be made for the substantial restructuring costs that would be essential for an orderly and planned transition to a smaller scale of operation. There is no prospect of accommodating such costs within present planning figures.

6.5 We cannot however believe that the Government regards it as sensible to reduce the research capability of an advanced industrial economy such as ours at a time of rapid technological development. We have noted earlier in this submission that the UK is already investing significantly less in civil research per capita and as a proportion of GDP than our major economic competitors. We have also noted the growing dependence of our economy on the existence of a broad-based research capability in this country which can generate the ideas, knowledge and trained people needed to translate scientific advance into technological and market leadership. The UK cannot realistically expect to lead the world across the whole range of scientific endeavour, but if we <u>generally</u> let other countries make the running, as is now beginning to happen, we shall impoverish the education and research training of our young people and lose <u>any</u> opportunity to reap for ourselves as a nation the potential commercial profits of technological leadership.

Chairman of the ABRC

14 July 1986

DEAR SIR DAVID

ABRC: 1986 PES ADVICE

Thank you for your letter of 28 April 1986 to my predecessor submitting the advice of the Advisory Board for the Research Councils on the Science Budget in relation to the 1986 Public Expenditure Survey.

I have read this with interest and I am sure it will be helpful in my discussions during the 1986 Survey. I am happy to agree that the advice should be published.

Yours sincerely

KENNETH BAKER

/9274
CSO: 3698/067

SWEDISH HIGH TECH FIRM EXPORTS CHECKED

Stockholm SVENSKA DAGBLADET in Swedish 7 Oct 86 Pt 3, p VI

[Article by Lennart Moberg]

[Text] Four Swedish, but foreign-owned, companies have been visited by the American Commerce Department. The Americans wanted to make sure that the companies had not sold high technology to the East Bloc.

The United States has directed its attention toward these Swedish companies, especially after the so-called Hakansson affair. Several years ago, Hakansson was suspected of smuggling computer technology to the Soviet Union. He could only be prosecuted for tax crimes in Sweden, however.

Export Ban

Four American and an English subsidiary with offices in Sweden that import goods from the United States are now being examined. The United States demands that companies dealing in American high technology not export or smuggle these articles to countries against which the United States has an embargo.

This applies to the entire East Bloc, Libya, Cuba, Vietnam, and other countries.

For this reason, three American officials from the Commerce Department have visited the four randomly selected companies in 1 day. These companies were the following:

Hewlett Packard Sverige AB. This is a wholly owned subsidiary of the world's largest computer company;

Perkin-Elmer AB, which produces instruments for analytical chemistry. The instruments are used to study water and air pollution, among other things;

Technitron is now an English subsidiary, but it imports instruments for military purposes from the United States. These products are sold only to Swedish customers, however;

Rosemount AB is an American subsidiary that sells control and regulator equipment to the processing industry, but also to the Swedish aviation industry.

Examining Routines

"The Americans were here because we are involved in high tech equipment and, in addition, we are responsible for the marketing of our entire company in the Soviet Union," Perkin-Elmer executive vice-president Torsten Bengtsson said. "They wanted to see how we follow our routines."

"Among other things, they wanted to make sure we had nothing to do with the black-listed Sven-Olof Hakansson--which we never have had."

9336
CSO: 3698/40

COMPANIES INDICTED FOR SELLING WAR MATERIEL TO IRAN

Stockholm SVENSKA DAGBLADET in Swedish 7 Oct 86 p 6

[Article by Torgny Hinnemo]

[Text] On Monday the first indictments will be handed down after an extensive investigation by customs officials into the export of explosives by Nobel Kemi. The executive vice-president and two other executives of a Finnish explosives company are being indicted for exporting 300 tons of TNT to Iran, with the help of Nobel Kemi.

The indictments are based primarily on extensive material gathered by Swedish Customs Police during their investigation of the sale of war materiel by Nobel Kemi.

According to the preliminary investigation the Finnish company Forcit, which is based in Hango, made two shipments of TNT totaling 300 tons to Iran. Forcit indicated that the shipments were for the Swedish company Bofors, but in reality the shipments never crossed the Swedish border.

Swedish Agency

According to the investigation, the deal was arranged by a Swedish businessman who operates an agency for reciprocal trade deals with Iran. In earlier interviews in the press, the businessman said he had arranged the sale of explosives from Nobel Kemi to Iran. Executive vice-president Hans Sievertsson of Nobel Kemi also confirmed to SVENSKA DAGBLADET that the company had sent a representative to Yugoslavia at the time the businessman said the deal was made. Sievertsson said, however, that he was unaware that Iran had been discussed.

When asked about Forcit by SVENSKA DAGBLADET, the businessman answered:

"I have never dealt with Forcit AB. I only discussed the deal with Nobel Kemi. You will have to ask them where they got the explosives."

But material from the Swedish study, which Finnish customs officials have also seen, indicates that both Forcit and the businessman knew about each other's role in the deal.

No Distinction Under The Law

Unlike Swedish law, Finnish law makes no distinction between explosives for military and for civilian use. All explosives exports require the approval of the government. In Sweden, TNT is classified as war materiel.

"In a sense, the question of whether or not to indict may seem simple," Hango prosecutor Simo Korppoo told SVENSKA DAGBLADET. "Nevertheless, I do not believe the trial will be simple. Finnish law in this area is defective and permits various interpretations. For this reason, the trial may set a precedent."

"Personally, however, I believe we have sufficient grounds for indictment," Simo Korppoo said.

'Unclear Legislation'

Following the indictments on Monday, the Forcit management and board will issue a communique. It states that the company believes it has followed the law and that the indictments are the result of unclear legislation.

The Swedish Nobel Concern is a part-owner of Forcit and Nobel Kemi is Forcit's most important foreign trading partner. The communique states that it is routine for Forcit to help the Swedish explosives industry fill orders when its own capacity is insufficient. Forcit also says it believes that the same regulations apply to both Finland and Sweden with regard to exports outside the Nordic countries. For this reason, Nobel Kemi has not been required to obtain any special certificate indicating the ultimate destination of the orders. In other words, Nobel Kemi has sole responsibility for the subsequent export, according to the Forcit management.

"We are disappointed in Nobel Kemi, which did not tell us where the TNT was to go," the indicted Forcit executive vice-president, Erkki Wiinamaki, said.

"I can confirm that Nitro Nobel purchased 300 tons of TNT from Forcit," Nobel Kemi executive vice-president Hans Sievertsson told SVENSKA DAGBLADET in connection with the communique. "The shipment was then sent to a company in Switzerland. At the time, we produced no TNT at the division that was then called Nobelkrut. We saw this as normal trading activity. In addition, I do not believe that this matter has been investigated to any great extent by the Customs Police."

Sievertsson said he knew nothing about the Swiss company's activities and did not know whether it had sold the TNT to anyone else.

Additional Information

The exact charges will not be determined until closer to the date set for the trial in Hango, 20 January. The Finnish prosecutor has been operating under the assumption that those involved should not have to wait too long to hear whether or not they were being indicted. This means, however, that the preliminary investigation is still under way and that the indictments may be complemented with additional information.

Permitted To 'Lend Name'

The deals on which the indictments in Finland are based will probably not be considered when the Swedish county prosecutor, Stig L. Age, decides whether or not to indict employees at Bofors and Nobel Kemi. There is no general legislation to prevent a Swedish company from lending its name for use in dummy transactions, as long as the company itself does not actively participate in anything that conflicts with Swedish law. There is only a special law, based on a United Nations convention, that applies only to exports to South Africa.

Eight Suspects

As a result of the investigation by Swedish Customs Police into exports by Nobel Kemi, eight persons at that company are suspected of crimes. These suspicions involve war materiel worth over 200 million kronor that is believed to have gone to warring countries in the Middle East during the eighties. The suspects have been given until 14 November to make a statement on the 5,000-page report from the preliminary investigation. Due to the size of the report, it is conceivable that they could ask for additional time. Only then can prosecutor Stig L. Age decide whether or not to indict the suspects.

Missile Sales

At the same time, police have been conducting their own preliminary investigation of Bofors' weapons exports for over 2 years. Their suspicions involve the sale of missiles, in particular, but also of other weapons to the Middle East. About as many persons are suspected of crimes in this investigation as in that of the customs officials. It is estimated that the preliminary investigation by the police will not be complete until the second half of November, however.

The customs and police investigations have taken several years because the investigators have systematically examined all correspondence and internal papers at Bofors and Nobel Kemi over a period of several years. As a result, the investigators believe they have determined that explosives were intentionally sent from Nobel Kemi to Middle Eastern countries to which the export of Swedish military materiel is prohibited. Yugoslavia and East Germany are indicated as intermediaries in these deals.

9336
CSO: 3698/40

SWEDEN'S ERICSSON AIMING AT SOVIET MARKETS

Helsinki HUFVUDSTADSBLADET in Swedish 15 Oct 86 pp 3, 14

[Article byBirgitta Jernvall Ingman: "Electronics His Triumph. Component Embargo Ending Soon? Ericsson Aiming At Soviet Market"; first three paragraphs are HUFVUDSTADSBLADET introduction]

[Text] Towards the end of the 1980's, the sale of certain American electronic components to the Soviet Union may again be allowed.

"This is something that the L.M. Ericsson Co. is looking forward to with joy. If the Soviet market is opened, the Finnish company will be like the spider in the middle of the net when it comes to Ericsson exports to the Soviet Union," says the president, Yngve Ollus. He says also that they would like to see a Finnish partner in the company, which is not wholly owned by the Swedish parent company, and that cooperation with the competitor, Noika, might be expanded.

Globally, there is a fight between about 15 telephone companies for a market that is hardly expanding anymore. In ten years time only 5-6 are expected to remain. The ERicsson company is counting on being one of them but, according to Ollus, the possibility exists that, by that time, it may have merged with another company. Siemens or Asea for instance.

Yngve Ollus, president of the L.M. Ericsson Co., says that certain American electronic components may again become available for delivery to the East by the end of the 1980's.

Despite the fact that the meeting between Reagan and Gorbachev in Reykjavik was not a success, there will be a green light again for the American components. "An Embargo cannot be maintained forever," says Ollus.

Lifting the technology embargo would have far-reaching consequences for Ericsson's eastern markets, where the embargo has constituted a great problem.

From the viewpoint of the Ericsson company in Finland, the development of the Soviet market is very exciting.

"We have every chance of success," says Ollus and mentions the possiblity of the company's three hundred software manufaturers developing and building systems for the Soviet market.

The Ericsson company has a licensed manufacturer in Yugoslavia, which for a long time has delivered equipment to the Soviet Union for about 200 million markkas per year.

"If the embargo is lifted, they can get the same equipment from us, from Sweden and from Yugoslavia. To a certain extent, we will then become like the spider in its net here, the distance between Helsinki and Moscow being shorter than that between Stockholm and Moscow."

Half Produces More

The L M Ericsson Co today has about one thousand employees. The number was reduced by 150 when the factory in Brahestad was sold at the end of July. For the last couple of years it had acted as a subsidiary to Salora-Nokia. It still does, but the factory is now owned by the city of Brahestad which leases it to another manufacturer. According to Ollus, a very good solution for all parties.

The Finnish subsidiary was the largest employer in the middle of the 1970's, when the number of employees reached 1,300. Less than 300 persons now produce more than 700 did then, in spite of the fact that the manufacture of telephone equipment has not changed that much.

The parent company has announced lay-offs. Is that to be expected in Finland also?

"So far we have taken pride in not laying off anyone. We do have some difficulties on the production side but nothing really serious. We have had trouble keeping about ten people busy so we sought contract work for them. We have also made part of the factory into offices and rather more people are needed on the administrative side."

Cooperation With Nokia?

The cooperation with Nokia, despite the earlier subcontracting, is rather insignificant. Not enough by far, according to Ollus, who thinks it will increase with time.

The two companies are serious competitors when it comes to public telephone centers in Finland. But Ollus says that the competition has become cleaner and more pleasant since Nokia, in its turn, has grown in Sweden.

Is it possible that Ericsson and Nokia might merge at some point?

"What would be gained, is the question that needs to be asked. What can they give us that we don't already have and vice versa," says Ollus. He states that Ericsson could give Nokia access to the world market. On the other hand, Nokia is in a better position in the Soviet market.

"There are points of contact and we are, of course, on speaking terms. The possibility might exist in the future, especially when the Soviet market is opened."

Seeks Finnish Partner

The L.M. Ericsson Co. would also like to have closer ties with Finland. Efforts have been made to find a suitable Finnish partner but so far without success. A Finnish partner would be in everyone' interest, according to Ollus.

About half of the almost fifty subsidiaries of Ericsson have other owners besides the parent company--Ericsson is even a minority stockholder in its "own" company in Norway.

The Finnish subsidiary is wholly owned by the parent company, but even here there should be many potential partners, according to Ollus.

Three large sectors

The annual return of the L.M. Ericsson Co. is about 600 million markkas, of which about 350 million markkas come from sales in Finland and 250 million markkas come from export to the parent company.

Three-fourths of the Finnish part consist of the three large sectors, i.e. telephone exchanges, public telephone centers and telephone sets. One fourth consists of intrusion and alarm equipment, private telephone systems, and work commissioned by the Finnish defense.

"On the whole, there is now a polarization within the computer and communications industry, with everyone returning to what they do best," says Ollus. Consequently, Ericsson has stayed away from the intrusion control system (which was sold to Wartsila) and the alarm equipment (which was sold to the Swiss Cerberus). However, the Ericsson company in Finland has remained as a representative for the new owners.

The sales in these two areas were also due to a wish for increased cash flow.

Computer Technology Via Telephone

Ollus is not expecting anything dramatic to accur in the domestic market during the next few years. Ericsson, Nokia, Siemens and ITT are expected to maintain their positions. But there are intensive preparations in the wings for the widespread changes that are expected to occur around 1990, when computer technology will be made possible by means of public telephone centers.

"Finland has always been far ahead when it comes to telephone technology," says Ollus.

Global Fight

Eventually, great changes are expected on a global level. At the present time, according to Ollus, a war is being waged between fifteen or so large manufacturers within telephone technology. In ten years it is estimated that only 5-6 will remain.

The demand for public telephone centers is presently at a maximum of 30 million lines per year (in Finland the increase is about 120,000 lines annually). The United States needs about 10 million lines and Europe 6-7 million. Europe has its own five or six manufacturers, Siemens, the French CGE, which bought the telephone operation of the American ITT, Ericsson, as well as the English and the Italians, who each have developed their own systems.

According to Ollus, a telephone system cannot exist without a market of a little over 2 million lines per year, which means that no company can make it in Europe alone without government subsidies.

The Ericsson concern does not have access to such subsidies. The domestic market in Sweden is insignificant, because the Swedish Telecommunications Administration is almost completely self-sufficient where public telephone systems are concerned.

In order to make a reasonable profit from telephone systems, given the current prices, Ollus feels that 4-5 million lines per year are required.

Siemens, Asea?

Will Ericsson be among the companies that remain after ten years?

"Yes," says Ollus, what else could he say. But he adds that the possibility exists that Ericsson might then have merged with another company.

In Europe, for instance, there is the manufacturer, Siemens, which still has not allied itself with anyone. The English with their System X are also without a partner, while both the French and the Dutch (Philips) have found their American partners.

As for Ericsson, there is Asea in the background. The notion that Asea should buy Ericsson has been raised in Sweden. "Communications and high tension Current could even each other out economically," says Ollus and adds that, as a rule, it is a question of obtaining large enough markets.

After all, Ollus believes that Ericsson will manage on its own without even a future merger by means of cooperation similar to that which has been initiated globally, within the banking sector, with Digital Equipment, and with Honeywell in connection with selling private exchanges in the United States.

Computer Flop

Ericsson's entrance into the computer field was a flop. According to Ollus, it was not successful at the beginning, but a suitable range has now been found. Hoping for rapid growth, the computer and the telephone companies jumped into each other's areas with less than happy results. The steep growth within the computer industry is now but a memory and the companies are in the process of returning to their previous areas.

"It's a question of concentrating on what you do best," says Yngve Ollus.

12339
CSO:3698/56

BRIEFS

ITT EQUIPMENT VIA FINLAND TO IRAN--The electronics giant, ITT, smuggled Electrical equipment to Iran via Finland and Kaukomarkkinat. This happened during the American trade embargo initiated by President Carter. Kaukomarkkinat was the official recipient of the goods, but when they were delivered here, they were re-packaged and sent on to Iran by way of the Soviet Union. "The information is old, and the incidents happened before I came with the company," says Ahti Sirkia, president of Kaukomarkkinat. He says that he does not know what happened or how it happened. "I only remember that there was something in the newspapers about Kaukomarkkinat and Iran," says Sirkia. The matter has been bought up again, because judgment has been pronounced on the American electronics giant, ITT, and it is now regarded as a criminally charged company. "Criminally charged" companies do not receive any orders from the government in the United States, and the judgment has already had time to hurt ITT. The judgment on ITT was pronounced following testimony by Bengt Beckman from Sweden about how he helped to sell goods to Iran via Finland. Earlier Beckman was one of the rising young executives in the multi-national ITT. The value of the secret trade smuggling via Finland was around 15 million markkas. [Article by Mosse Wallen: "Kaukomarkkinat Implicated: ITT Was Smuggler"] [Text] [Helsinki HUFVDUSTADSBLADET in Swedish 15 Oct 86 p 15] 12339

NORWAY SOLD HEAVY WATER TO ISRAEL--The Norwegian Ministry of Foreign Affairs has confirmed the newspaper information that Norway twice exported heavy water to Israel. In 1959, 20 metric tons of heavy water was exported and in 1970, one metric ton was delivered. According to the Norwegian Ministry of Foreign Affairs, the contract with Israel stipulated that the heavy water be used only for peaceful extraction of atomic energy and that the heavy water not be conveyed to a third party without Norwegian consent. Norway also made an inspection in Israel in 1961 and the Norwegian commission stated that there were no reasons to believe that Israel had violated the contract. In 1970, Norway received a request from Israel for four more metric tons of heavy water, but the request was denied because of the political development in Israel. [Text] [Helsinki HUFVUDSTADSBLADET in Swedish 15 Oct 86 p 18] 12339

SWEDISH TECHNOLOGY TO LDC'S INCREASES--The transfer of technical knowledge from Sweden to developing countries is increasing considerably. Last year, the Committee for Technical-Economic Cooperation (BITS) paid out 600 million kronor in assistance. The year before, the amount was 370 million kronor. Assistance in the form of technical knowledge goes to some twenty developing countries.

Even more countries participate in courses, among them paper technology, telecommunications technology and business administration. BITS is asking for 685 million kronor for technical assistance in the fiscal year of 1987-88. Furthermore, BITS grants credit to developing countries. [Text] [Stockholm NY TEKNIK in Swedish 2 Oct 86 p 10] 12339

CSO:3698/56

GDR USE OF BIOTECHNOLOGY IN PHARMACEUTICAL PRODUCTION

East Berlin TECHNISCHE GEMEINSCHAFT in German No 8, 1986 pp 4-5

[Interview with Dr Michael Oettel, director of research and development at the VEB GERMED Pharmaceutical Combine, Dresden, Dr Klaus-Dieter Hoffmann, chairman of the enterprise section of the Chamber of Technology at the main plant, the VEB Pharmaceutics, Dresden, and Dr Juergen Langer, chairman of the special operations section Biotechnology; unnamed correspondent, date and place of interview not given]

[Text] Microorganisms are also an effective medical raw material. Using procedures from biotechnology, highly effective pharmaceuticals with completely new therapeutic characteristics can be manufactured. In an interview with Dr Michael Oetten, director of research and development at the VEB GERMED Pharmaceutical Combine, Dresden, Dr Klaus-Dieter Hoffmann, chairman of the enterprise section of the Chamber of Technology at the main plant, VEB Pharmaceutics, Dresden, and Dr Juergen Langer, chairman of the special operations section Biotechnology, TECHNISCHE GEMEINSCHAFT discussed what paths must be followed to provide the health industry with more substances of this kind.

[Question] Prof Oettel, what value is assigned to biotechnology in your combine for the further development of highly effective drugs?

Oettel: Biotechnology, including genetic engineering, will make it possible to produce selected pharmaceutics more efficiently than before. And that is not all. With biotechnology, we can obtain drugs which, using purely chemical methods, either cannot be manufactured at all, or are extremely expensive. I am thinking, for example, of preparations against illnesses which either could not be treated or could be treated only inadequately with chemotherapy. This includes certain illnesses involving viruses or tumors.

A broad range of antibiotics developed through biotechnology has been available for some time, but biotechnological development, including the sector for the production of pharmaceutics, is proceeding at a furious pace and it offers great opportunities for the future. I would like to stress that our combine is continuing to develop the manufacture of medicine, not only on a biotechnological, but also on a chemotechnological base.

[Question] Please identify some characteristic aspects of the continuing development of biotechnology at the GERMED combine.

Oettel: We are facing an interrelated complex of tasks, which are bound up with our plan for scientific research and technological development. These tasks concern both research and development and how to translate this into production, as well as production itself. One of our concerns is to raise traditional biotechnological processes, fermentation for instance, to a higher level of manufacturing technology. This will be done in part by applying modern microelectronic and computer-aided measurement, control, regulation and monitoring equipment, and in part by introducing highly efficient, up-to-date biotechnological processes. These include, for instance, genetic engineering, with its revolutionary possibiliities, and protein and immunotechnology, because they make it possible for us to obtain new, highly effective drugs in an efficient way.

It is obvious that these plans within the combine can only be carried out with creative interdisciplinary work between the individual combine operations, and to do this, researchers, developers and technicians have to work together equally. Here is the important coordinating role that falls to the gremiums of the socialist engineers organization. That becomes clear primarily in the collaboration with partners who do not belong to our combine, such as the Academy of Sciences and other research institutes and enterprises, like the VEB Chemical Plant Construction, Leipzig-Grimma. It is one of the most suppliers for our combine and the general contractor for a new fermentation plant in Neubrandenburg.

[Question] Which projects will the GERMED combine concentrate on in the next few years to satisfy the requirements of the economy?

Oettel: In April of this year, the GERMED combine waa attached to the Research Center for Biotechnology in Berlin. This was done so that all the new, modern methods, which characterize the current state of biotechnology and which will substantially determine it in the years ahead, can be made an effective part of production as quickly as possible. The Research Center has a specialized genetics engineering center assigned to it, which is currently under construction in Berlin-Marzahn as a young people's project. It is intended specifically for the genetic manipulation of bacterial strains, up to the level of mammalian cells. A second center of this kind is being built in Dresden.

The assignments for the genetic engineering center in Berlin consist primarily of "constructing" microbial agent producers for the manufacture of pharmaceutics. That will be carried out on a laboratory scale, but also on a pilot scale.

In the Dresden center, the main emphasis in research is primarily on developing suitable methods for biotechnological preparation, separation, purification and filtration. That sound simple, but in the case of agents produced by means of biotechnology for the drug industry, it is extremely important to observe different parameters precisely, including a high degree of purity. That makes heavy demands on the fermentation plants, and particularly on the preparation plants.

Other important initiatives from our combine include the expansion of a modern fermentation plant, the VEB Pharmaceutics in Neubrandenburg, for the manufacture of penicillin. The future production of Alpha-1-Interferon is a matter of outstanding importance--the subject of an initiative that our combine is implementing jointly with partners from the Academy of Sciences of the GDR.

[Question] The operations section of the Chamber of Technology at the main plant, the VEB Pharmaceutics in Dresden, is among those gremiums which actively participate in implementing projects in biotechnological matters. Which solutions are being worked on?

Hoffmann: In our combine enterprise, biotechnology challenges the activity and creativity of our engineering organization staff, because biotechnology, as the word says, is at least as much technology as it is biology, and the technology in this area extends over many, many different levels, because it has to deal with living organisms.

Over the longer term, the section staff is working within the combine structure on Chamber of Technology projects, two of which I would like to mention. One of the Chamber projects is the construction of a Technical College for Synthesis at the main plant in Dresden, the other one is an experimental plant for biotechnological processes, also in Dresden.

The Technical College will help to bring new pharmaceutics to production and, in addition, will assist in the test production and, on a limited scale, in the plan production of medicinal agents. It will be set up in such a way that we can generate a lead in the processes and reactions needed to modernize and rebuild existing installations at the enterprises. One priority assignment for the Technical College is the chemical derivation of products obtained by means of biotechnology and their conversion into effective drugs, particularly antibiotics and those for chemotherapy treatment of cancer.

The experimental Biotechnological Processes plant is assisting in the development and production research of highly effective pharmaceutics. On the reaearch side, the emphasis is on the mastery and optimization of bioprocesses from the standpoint of procedures. The use of gene manipulated microorganisms is planned in a small fermentation project. The derivation of agents from the microbial cultures and from plant and animal organs is then carried out in a special preparation plant. When this project is completed by the end of the current 5-year plan, the transfer capacity of the GDR's pharmaceutics will have been substantially increased. The process engineer in particular will be able to develop additional highly efficient production processes, using scientifically based methods.

[Question] That requires close cooperation from all those who have broad experience in this area. How is this cooperation being encouraged in the combine?

Langer: In order to realize these quite extensive plans and to solve the many technological problems associated with them in the specified time period, while maintaining quality, a special operations section for biotechnology was created last year through the enterprise section of the Chamber of Technology. The intent was to bring together all the forces working in this specific area and to channel their activities and creative work in a common direction, because new techniques which go far beyond the traditional have to be learned.

Although our priority at the main plant continues to lie in the area of fermentation, it will be necessary to introduce new techniques, particularly those for the extraction of proteins. The entire preparation technique has to be modified and perfected. On the average, some of the present-day techniques give a yield of about 20 to 30 percent. This can be substantially increased if all the procedural processes can be optimized from a scientific and technological standpoint.

The special section in the VEB Pharmaceutics factory, Dresden, does not consider its future assignments to consist only in helping to solve problems in biotechnology in its own enterprise, but rather in collaborating with other enterprise institutions in the Dresden Bezirk that are active in biotechnology. Examples are enterprises in the food industry and chemical plant construction. The VEB Complete Chemical Plants, Dresden, is an extremely important partner for us, from a long-term point of view, as a supplier of special equipment for biotechnological production lines. Like other enterprises, it has a long tradition in the manufacture of complete special equipment assemblies. Our activity will take a very interdisciplinary form, there is no alternative if we intend to implement our plans.

[Question] From your viewpoint, Dr Hoffmann, how does the enterprise board of the Chamber of Technology in Dresden support the initiatives of the enterprise section in providing the necessary impetus in scientific research and technological development for this key technology, biotechnology?

Hoffmann: To cite a concrete example right away: In January this year, a working committee for biotechnology was formed at the enterprise board level in preparation for the 11th SED Party Congress. This was an important step towards future expansion of this key technology in the bezirk, as requirements demand. All the "appropriate" enterprises in the bezirk are represented on this working committee. Our enterprise was assigned the leadership role.

This year we are organizing consultation sessions in the individual enterprises in our bezirk. They are points of departure for future joint solutions. A working program, which includes lectures, has already been drawn up for these meetings. In June the first consulation along these lines was held at the VEB Pharmaceutics Works, Dresden, and the special lectures, for instance, on the topics of "Ranking Biotechnology in the Creation of Pharmaceutics" and "Questions in the Microbial Creation of Pharmaceutics" were of great interest to the Chamber of Technology representatives from the enterprises.

The expansion of biotechnology into a science is bringing such an enormous growth in knowledge that its effective use in the units working in biotechnology, including production, cannot take place in isolation, and we, as members of the Chamber of Technology, intend to take this fact into account.

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CSO: 2302/9

UDC 66:65.3.011.331.87(497.1)=861

YUGOSLAV CHEMICAL INDUSTRY: DEVELOPMENT, IMPORTS

Belgrade TEHNIKA in Serbo-Croatian No 6, 1986 pp 564-567

[Article by Dr Vera Knezevic, Economic Chamber of Yugoslavia, Belgrade: "Survey Paper: Problems of Industrial Property in the Chemical Industry"; introductory paper for a round-table discussion on the topic: "Problems of Industrial Property in the Chemical Industry," held in the Economic Chamber of Yugoslavia on 27 June 1985]

[Text] The overall social and economic situation in the country demands that the country's future technological development rely to the greatest possible degree on our own resources, which directly implies maximum reliance on our own research and development results arrived at in the domain of top-level research as well as in the domain of innovations created at all levels of human activity.

Because of the extremely high price of scientific activities and research, the knowledge produced has its market value and can be sold and conveyed like any commodity. The buying and selling of knowledge has been developing according to all the laws of the market, since it has immense strategic importance because of the constant need for the country's technological development. The proprietary nature of knowledge has been set down in the international system for protection of industrial property, which is markedly monopolistic in character, and the doctrine of the capitalist countries is dominant in it.

In the postwar period the chemical industry has had a considerably faster development than the industrial sector as a whole, so that the share of this industry, calculated relative to the social product, has grown from 5.2 percent in 1965 to 9.2 percent in 1982. The chemical industry has thus achieved the lower boundary of the moderate level of development.

Since the chemical industry is highly dependent upon the technology applied in production processes, and since this knowledge is mostly the property of the most advanced industrial countries, this factor has had and still does have immense importance in the development of national chemical industries.

In order to obtain the necessary knowledge for successful development of the chemical industry, sizable investments have been made in research to master present-day processes in chemical technology, and at the same time our own machinebuilding industry was equipped so as to be able to keep pace with the production of equipment, devices, and complete installations, so that the results achieved in research could be successfully applied in practice.

Nevertheless, the development of research and the output of knowledge necessary to carry on the programmed development have been lagging behind real needs. The orientation toward the purchasing of intellectual services (design, engineering, and know-how) has affected practically all of the large facilities, and cooperation with foreign design and engineering organizations has not been organized so as to involve domestic specialists so that they might develop this activity within a domestic framework. Processes or designs have been purchased for the same or a similar production operation from different foreign firms, and at the same time the knowledge already purchased has not been fully utilized. The figure on the multiple purchasing of a license for the production of sulfuric acid or for aspirin has become a commonplace. However, it is disturbing that this practice is still going on, not only in the purchase of licenses, but also in other forms of economic cooperation between organizations of associated labor and foreign persons.

The principal reasons for the excessively large reliance on importation of knowledge and technology, which to some extent are understandable, lie above all in the need for the country's faster development, and they also lie in a desire to reduce the risk in making investments, especially to make up for the shortage of our own investment capital, and to some extent the inappropriate capacities in the domain of domestic machinebuilding, design and engineering organizations, and the low efficiency of the domestic research capability.

The lag of the domestic scientific research potential also occurred because of the several years of neglect of the physical facilities and personnel of the domestic scientific research capability, which has not managed to create a domestic technology in many fields even after 20-30 years, since the investments in scientific research have been inadequate, even in many quite large organizations of associated labor. Excepting our well-known firms which base a major portion of their production on their own technology, for the rest it is an imperative to achieve reliance on their own resources through better organization of the research potential, by pooling labor and capital, by concentrating personnel along particular primary lines of development, and especially through mutual division of labor. That is, the main directions in development of the overall Yugoslav chemical industry must be determined by the strategy of technological development, and then the division of labor accomplished in certain fields within research and in production. It is in the context of considerations of this kind that science must become one of the key forces in our overall development, and the strategy and policy of the long-range development of science must be made to serve the strategy and policy of the country's long-range socioeconomic, technological, and social development.

Studies of the transfer of foreign technology to Yugoslavia show that Yugoslav economic entities have been concluding a rather large number of licensing agreements with foreign partners, while the number of contracts calling for the export of Yugoslav equipment and technology to foreign customers is relatively small.

According to analyses conducted by the General Association of the Yugoslav Chemical Industry, in 1979 there were 432 contracts concluded to obtain foreign technology for domestic organizations in industry and mining, and 122 of them (or about 28 percent) were in the field of the chemical industry (along with the rubber industry). That same year there were seven contracts concluded (five of them in the chemical industry) on making our technology available to foreign entities. That same year there were 17 contracts concluded in the chemical industry concerning long-term industrial cooperation, 59 contracts on business-technical collaboration, and 30 contracts on investment of foreign persons in domestic organizations of associated labor. That same analysis shows that in that same year, 1979, there were a total of 1,168 contracts in industry and mining calling for all forms of economic and technological cooperation and that those contracts were concluded by 518 organizations of associated labor. Within those figures 103 organizations in the chemical industry concluded 245 contracts (20.9 percent).

In 1979, 211 contracts were to be performed in the domain of the chemical industry, 131 of them were carried out completely, 75 partially, and 5 contracts were not carried out at all. As for the subject matter of contracts to obtain foreign technology, the following can be cited: production of sulfuric and phosphoric acid and polyvinyl chloride, and then pharmaceutical and cosmetic products, etc. It is a characteristic of all these contracts that mostly the license did not call for royalties as the form of payment, but rather this was contained in the purchase price of the basic ingredient of the particular drugs or other products which had to be purchased from the foreign party to the contract. Here it was very often a question of contracts to obtain the right to use protected trademarks or the technology for finished production, i.e., for packaging drugs or cosmetics, which required use of the pharmaceutical or cosmetic raw materials of the foreign party to the contract who was granting the license. At the same time, all five contracts whereby domestic technology was made available to a foreign firm had to do with the production of drugs.

Licensing agreements have been concluded for varying lengths of time, but contracts with a life of 7-10 years have been predominant. A certain number were concluded for indefinite periods of time (that is, until canceled); these are the contracts which pertain mostly to the packaging of drugs and cosmetics, and they usually contain a clause calling for automatic extension of the contract unless one of the parties cancels before the life of the contract expires.

Among the adverse aspects of the contracts we should mention that in the pharmaceutical and cosmetics industry the domestic partner has frequently been required to make purchases of the basic ingredients exclusively from the foreign partner, not on the open market. In a majority of the contracts which have to do with obtaining the right to use a protected trademark and technology for packaging products, the right to manufacture automatically terminates when the contract expires. This pertains above all to the production of drugs and cosmetics as well as to the production of certain detergents.

In the pharmaceutical and chemical industries there are a large number of contracts whereby domestic manufacturers obtained the right to use a protected trademark in exchange for certain obligations. In 1979 organizations of the chemical industry paid lump sums of 5.26 million dinars for trademarks and another 13.864 million dinars on a periodic basis.

The payment of license fees in the form of mandatory purchasing of raw materials at prices set by the licenser has been most widespread in the pharmaceutical and cosmetic industries and then in the production of commercial fertilizers, detergents, and other products.

The accelerated technological development of our economy in general and also of the chemical industry in particular has been achieved, as has already been said, mainly by purchasing licenses for technology and through the purchase of equipment, and to a lesser degree through the other forms of economic and technological cooperation with foreign countries. It is well known that over 50 percent of the equipment installed in the chemical industry is of foreign origin, as indeed are many of the key components.

It must be pointed out that in certain fields we have nevertheless managed to introduce domestic processes and use domestic engineering. According to the most recent figures, this especially applies to the field of agricultural chemicals (fertilizers, chemicals for plant pest and disease control), where the ratio of domestic and foreign processes and also engineering applied is almost in balance and amounts to 1:1.66. In the plastics field the ratio is somewhat less favorable at 1:1.93.

Unfortunately, the ratio of domestic and foreign processes applied is quite unfavorable in the field of chemical fibers and the production of heavy chemicals (inorganic and organic): 1:7.50 for man-made fibers, 1:7.25 for heavy inorganic chemicals, and 1:3.57 for heavy organic chemicals. In those same sectors engineering work was done by domestic or foreign organizations in the ratio of 1:4.66, 1:5.00, and 1:3.75, respectively. It can be concluded from these figures that complete engineering was domestic in the domestic processes applied, and that the share of domestic engineering in the foreign processes applied varied greatly.

In the sector of pharmaceutical production, especially in the packaging of products, the development of technological resources was achieved by generating information and knowledge from foreign firms (formulas and instructions) from whom the basic raw materials or active ingredients were obtained, or from engineering organizations and equipment manufacturers from whom the relevant know-how was obtained.

In the process of concluding contracts for the transfer of technology, as experience has shown, we still do not have enough knowledge today to oppose the introduction of many restrictive clauses. The Federal Bureau for Patents analyzed the validity of 100 licensing agreements with respect to restrictive clauses on several occasions over the period from 1973 to 1983. According to these analyses, over the period from 1973 to 1977, 98 percent of the contracts contained at least one of the restrictive clauses. We should emphasize in this connection that the identification of the restrictive clauses was made on the basis of the methodology of UNCTAD and the materials of a group of experts who worked on the draft of the code of behavior in the field of transfer of technology and the draft of the code of Group 77, in which 32 restrictive clauses were defined.

The restrictions occurred most frequently concerning the free application of the technology acquired and the obligation to pay charges even after patent protection expired (62 percent of the contracts); 44 percent of the contracts placed direct restrictions on development of the licensee's own research, and 48 percent of the contracts also called for certain restrictions on exports. In addition, before enactment of the new law on protection of inventions, technical improvements, and distinguishing marks, legislative regulation allowed for a monopoly of the market, and only 0.15 percent of the patents applied for were applied in production.

An analysis dating from 1983 (covering the period from 1978 to 1981) identified nine restrictive clauses referred to in the Law on Long-Range Industrial Cooperation, Business and Technical Collaboration, and the Acquisition and Cession of the Material Right to Technology Between Domestic Organizations of Associated Labor and Foreign Persons. However, the analysis also identified other restrictive clauses not covered by the law, though they were covered in the UNCTAD methodology mentioned. The analysis shows that the law had an influence on the quality of contracts and that the number of contracts in which restrictive clauses were included had dropped to 49 percent.

One of the serious problems standing in the way of a good knowledge of this subject matter is that the regulations on industrial property are very scattered over several different laws whose provisions on the same issues are often contradictory. Thus this subject matter is regulated by the Law on Protection of Inventions, Technical Improvements, and Distinguishing Marks, the Law on Copyright, the Law on Release of Drugs for Sale, the Law on Control of Disloyal Competition and Monopolistic Agreements, the Law on Contract Law, the Law on Long-Term Industrial Cooperation, Business and Technical Collaboration, and Cession of Material Rights to Technology Between Organizations of Associated Labor and Foreign Persons, and indeed even the Law on Associated Labor. And then this leads on to the great variety of internal normative acts which contain provisions on innovative work in the organization and on protection of industrial property.

Because the Law on Protection of Inventions, Technical Improvements, and Distinguishing Marks (SLUZBENI LIST SFRJ, No 34, 1981) is one of the most important, since among other things it also regulates the question of domestic creativity, and also because certain specialists are continuing to insist on those dilemmas which were known earlier, we must emphasize that even during the very lengthy discussion which preceded enactment of the new law, nor since that time, have the aims of the law been in dispute. It was, that is, enacted, as stated in its Article 1, for the purpose of: stimulation of creativity whereby up-to-date domestic technology is developed, productivity of social labor is increased, the quality of products, processes, and services is improved, and the material base of associated labor is expanded; to create conditions for expansion of technological collaboration on an equal basis with other countries and inclusion in the international division of labor in the field of technological creativity; the application of inventions in production; protection of the interests of consumers and the interests of OUR's on the unified Yugoslav market; and on behalf of protection and improvement of the environment.

That being the case, then there certainly is no dispute that the various provisions of the law must be evaluated with respect to achievement of the goals that are set. Here we must not overlook the fact that the protection offered by the law is not in and of itself sufficient to achieve those goals. Protection comes at the end of a process whose successful accomplishment involves solving many problems, first of all those concerning the organization and financing of innovative activity and the application of its results in physical production.

The relatively small number of rights protected on behalf of holders in our country and, one might say, the marginal use in production of the results which are the subject matter of that protection suggest the conclusion that there are problems in our country and they still have to be solved. At the same time, the large number of rights protected on the basis of holders from the advanced countries of the world shows that protection has its true importance for them, i.e., that it affords them material gain and a solid basis for further development. It is necessary, then, for us to examine the features of the new law in that light as well so as to evaluate what this new law brings to or takes away from the Yugoslav economy and what it does to or for the foreign holders of the rights. A discussion that runs along that kind of framework would undoubtedly yield constructive results in evaluating the effects of the new law.

Pursuing our reflections within the framework just set up, let us turn attention to Article 45 of the new law as a place to start the discussion. Under that provision an exclusive right to market products manufactured on the basis of an invention, referred to as "market monopoly," exists only in the case when the invention in question is applied in production within the SFRY. This provision, in our opinion, undoubtedly contributes to achievement of the goals of the law as stated above. If, say, an invention is not applied in production in the chemical industry and is not contributing to the development of the productive potential of an OUR, is there then any justified interest in the chemical substance in question being for sale on the open market? Why, for example, pay a monopoly price in the pharmaceutical industry for a substance which can be purchased from sources which are not bound by the holder of the patent, at prices which are often a mere fraction of those offered by the holder of the patent?

It would be good for representatives of the chemical industry to also evaluate the fact that the number of patents applied for by foreign holders has dropped off considerably in the pharmaceutical industry since enactment of the new law. Is this perhaps evidence that in this area the patent was used for marketing products rather than for the transfer of the technology covered by the patent? It ought not to be our task to furnish foreign partners the greatest possible motivation to register their patents in Yugoslavia if that motivation does not at the same time represent an authentic desire to broaden the material base of associated labor through the transfer of those technologies.

At this point it is not possible to offer an altogether precise answer, but there are data from the period before enactment of the law showing that only 0.3 percent of the inventions on which patents were applied for are applied in production, which is rather indicative.

As for the use of the trademark as a specific form of industrial property (distinguishing mark), the Law on Release of Drugs for Sale (SLUZBENI LIST SFRJ, No 58, 1976) compels our manufacturers to sell drugs under their own trademark, which means that our own organization is the owner of the trademark unless the drug goes under a generic name. The demand of foreign firms that medical products be sold in our country under the trademark of the licenser is entirely commercial in nature and is aimed at creating a permanent "presence" on our market. They do not, of course, give capturing the market as a reason, but rather the fear that our organization will not guarantee the product quality prescribed by the licensing agreement. It must be said in defense of our statutes that this objection is not valid, since the foreign firm has the right to monitor the quality, and it does in fact exercise that right. These enactments apply only to the Yugoslav market, but as far as possible exports are concerned, our products must use the foreign trademark. However, such an enactment does not unfortunately exist for other types of products: pesticides, foodstuffs, and cosmetics. Foreign names dominate our market, and foreigners thereby get a free market and collect compensation in the form of the higher value of the price of the raw material or actual royalties.

To be sure, there does exist Article 134 of the Law on Protection of Inventions, Technical Improvements, and Distinguishing Marks, under which the organization of associated labor using a foreign trademark must in addition to that trademark use its own trademark, and the latter must be displayed with equal visibility. The question is how many people even know about the existence of that article of the law and still more how much that provision of the law is respected? Perhaps the only oversight on the part of the legislator was that he did not find instruments to guarantee respect for this statute in this area, although there is unquestionably an oversight in ourselves as well.

When it comes to the features of the law that would give occasion for criticism, nothing will be gained from repeating the criticism made in the proceedings that came before enactment of the law and adopted at that time, unless arguments are presented which are drawn from practice. It would be worthwhile for us to direct the discussion toward presentation of specific experiences related to application of this law, so that through the discussion of those experiences we can locate the problems whose solution the law is helping or perhaps hindering. Only if we establish in this way that specific problems have already accumulated in practice and are the consequence of inappropriate legal provisions can we undertake to reassess those provisions and seek better ones, still along the line of the goals that were set.

As for the law, it seems to us, the greatest problem is its enforcement in the country, that is, enforcement of the obligations of the organization of associated labor to organize its own development, to draft the appropriate normative acts, to create services for protection of industrial property, and so on. Another problem that is an urgent one is that of training personnel for this field and devising an effective information system.

Finally, the discussion of the problems of protection of industrial property would not be complete unless we also took up the problem of domestic creativity, that which comes under organized research and that which is almost independent, based on independent initiative, and taking place within associated labor and outside it. In any case inventive and creative work represents one of the basic resources of every present-day society, and the rise of labor productivity and development of engineering and technology are based to the greatest degree on the application of innovations. The true measure of the development of inventive activity is the number of patents applied for and protected and also the data on the number of technical improvements, worthwhile proposals, and all other possible forms of innovations which are registered and applied.

Without going any deeper into an analysis of the situation in this field in our country, we will give some figures which are rather characteristic of the period before and after enactment of the new legal provisions.

According to figures of the Federal Bureau for Patents, in 1983 there were in all 1,455 domestic patents applied for, and 126 registered. In 1984 there were a total of 1,369 applications and 152 domestic patents registered. Of these the chemical industry (based on the International Classification of Patents in Section C, subsections from C-01 to C-12, except C-03 and C-04--glass, mineral wool made from slag, cement, ceramics, etc.) applied for a total of 98 domestic inventions, and 7 were registered; in 1984, 77 applications were filed for domestic patents, and 68 were registered. Most of the patents were applied for and registered under Subsection C-07--Organic Chemistry, as follows: in 1983 there were 4 domestic and 25 foreign patents, and in 1984 the figures were 56 and 400, respectively.

As for foreign applicants, in spite of all the charges made against our law on protection of inventions, technical improvements, and distinguishing marks, their applications in the chemical industry are between four- and fivefold more numerous than domestic ones: 433 in 1983 and 330 in 1984. The ratio is 1:7.42 in favor of foreign patents with respect to the protection achieved in 1984.

As throughout the entire period up to now, the number of applications of individuals far exceeds the number of applications of OUR's and institutes (1,184:158:63 in 1984), while the number of patents registered shows a certain advantage of the OUR (51:76:25). That same year there were 888 applications, and 616 foreign patents registered.

We do not have figures on protection of our inventions abroad for 1983 and 1984, but we do know that in 1982 protection was applied for on only 31 of our inventions. The costs of protecting inventions are much higher abroad than in the SFRY. It is assumed that the minimum cost of protection for one invention in an advanced country is $1,000. Nevertheless, individuals find an interest in protecting their inventions more than do, say, institutes (in 1982 there were 17 OUR's, 2 institutes, and 12 individuals).

In the period from 1973 to 1982 application was made to the Federal Bureau for Patents on 13,201 inventions, and protection was applied for abroad on only 388 inventions (2.9 percent). Each of these inventions obtained protection in 4 countries on the average (1,496 patents).

It is an indicative figure that three of our work organizations which have highly developed industrial property departments (Lek, Iskra ZP, and Pliva) have obtained more patents abroad than all other organizations of associated labor taken together.

With respect to the fields of technology, the largest number of inventions protected are in Section C (Chemical Industry and Metallurgy)--103; Section H (Electrical Equipment)--74; Section F (Power Machines and Pumps, Illumination, and Heating)--64. In a breakdown by countries, the largest number of inventions were protected in West Germany (307), and then in France (154), and Great Britain (129).

An analysis of the protection of distinguishing marks--trademarks, models, and designs, the most interesting of which for the chemical and pharmaceutical industries are trademarks, shows that in 1978 1,191 trademarks were recorded by emergency procedure on drugs being released for sale, while in 1984 155 trademarks on drugs were recorded. As for foreigners, applications for the largest number of trademarks were granted to applicants from the United States (123), and then Great Britain (70), and Japan (24).

Our organizations do not take advantage of international protection of trademarks through the Madrid Arrangement, which is in line with the export orientation of the economy. In addition, it should be borne in mind that trademarks, like patents, constitute capital assets of organizations of associated labor and that particular attention should be paid to them.

Regular periodical surveys have been made in the field of industrial property in the Federal Bureau of Statistics (IND. 21. 10.1-10.4). According to these figures, there were 116 inventions applied in all of Yugoslav industry in 1983. According to the figures of the Federal Bureau of Statistics, those are inventions that were put in use in 1983 or which had been introduced earlier and were still in use. According to the same figures, in 1983 there were four domestic patents in use in the chemical industry, that is, in a portion of the chemical industry, Branch 119--Manufacturing of Chemical Products, for example. At the same time four foreign licenses, valued at 10.986 million dinars, were being applied.

There are interesting figures of the Federal Bureau of Statistics related to technical improvements and worthwhile suggestions which are not subject to protection and which the Federal Bureau for Patents does not record (IND. 21. 10.1-10.4).

In all of Yugoslav industry there were 2,083 domestic technical improvements applied in 1983 in 525 organizations, while there were 1,983 worthwhile suggestions applied in 494 organizations.

In Branch 119--Manufacturing of Chemical Products, there were 129 technical improvements applied in 48 organizations, and there were 78 worthwhile suggestions applied in 26 organizations.

In addition to these figures on the state of creativity in our country, the attitude of the professional management structure toward obligations which organizations of associated labor must discharge on the basis of positive legislation is undoubtedly important. One such obligation is that organizations of associated labor are to organize development of creativity in the best possible manner and adopt the appropriate normative acts. However, throughout Yugoslav industry only 2,489 organizations have their own regulation on innovations, and only 703 organizations have organized their own department for innovations. In the industry for manufacturing chemical products 162 organizations have their own regulation on innovations, while 65 organizations have their own department for innovations.

It is obvious that the situation is far from good, and, put most crudely, it is a question of a lack of personal motivation, poor organization within OUR's, and insufficient motivation of the professional management structure to develop creativity and apply innovations. Given this assessment of our own future, the figures from certain advanced countries sound almost unlikely. For example, in 1982 the number of suggestions made for various innovations in the United States was 144 suggestions for every 1,000 persons employed (which means nearly 1 out of every 7 employees), and 27.5 percent of those were adopted. The largest individual bonus paid in the United States in 1982 was $100,000, and the average was $244. A savings of $10.40 was obtained from using those suggestions for every dollar invested.

The overall state of affairs in the protection of industrial property in the chemical industry indicates the full seriousness of the problem, which must be resolved in very broad discussions concerning consistent enforcement and operation of legislation and voluntary regulations and concerning the obligations of professional managers to facilitate the development of our own creativity, and especially concerning the need to train personnel to work in this field.

7045
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COMPUTER TRAINING INSTITUTED IN 150 GDR ENTERPRISES

East Berlin NEUES DEUTSCHLAND in German 20 Aug 86 p 2

[Article by Klaus Morgenstern: "Trainees Learn at the Computer--Data Processing Course to be Offered at 150 Technical Schools Beginning in September -Additional Computer Classroom until 1990"]

[Text] When the 1986/87 school year begins in a few days, two classrooms at the Works Training School of the "October 7th" Berlin Machine Tools Cooperative will be newly equipped: 10 Robotron KC 35/2 computers with peripherals will be available for use by trainees.

The Berlin vocational school is one of about 150 at which a basic course in data processing will be given on a trial basis starting in September of this year. This course is part of the new "basics of automation" curriculum which as of 1986 replaces the previous basic courses in electronics, data processing and industrial measurement and control. The data processing training is being introduced primarily for occupations that directly involve the use of computer technology, and for all trainees working for a secondary school diploma in the technical fields. These trainees are receiving an expanded course of training in data processing, amounting to about 72 hours, to prepare them for future study and for their later entry into the scientific and technical areas of industry. For the other trainees the course is 36 hours.

During this phase of their education they will receive a solid background in information processing, BASIC programming language and the necessary software, and will gain a mastery of calculating technique.

This project is considered especially important since many of the roughly 918,000 young technicians who are being trained during the current 5-Year Plan will find jobs in automated areas of production. The directive on the 5-Year Plan, of course, calls for the percentage of manufactured goods produced by automation in the GDR to triple by 1990. 85,000 to 90,000 CAD/CAM work stations will be set up over the same period. To ensure that the current crop of trainees will be ready for these developments, the network of computer classrooms will gradually be extended throughout the technical school system. Technical training is one of the areas in our republic where modern computer technology is being introduced on a priority basis over the period from 1986 to 1990, and in a few years the data processing course will be on every student's schedule.

This is only one side of the coin, however. Over the past weeks and months teachers in many localities have been coming back to the classroom as students again to obtain a solid foundation in the basics of automation, especially data processing. In addition, along with the textbooks and experimental manuals for this subject, a package of other materials--a brochure with 32 computer programs and accompanying cassettes--has been put together specifically for data processing training.

In the meantime, young people at some of the technical training schools which have had computer classrooms since last year have been starting their own projects. Members of the FDJ, working with experienced specialists, have taken over the technical maintenance of the equipment. "Fair of the Masters of Tomorrow" collectives are developing job-specific software which is also intended as a teaching aid.

The students' response has been enthusiastic. At many of the schools which have been provided with computer classrooms, the display screens are still glowing even after classes are over for the day, and FDJ computer clubs have been organized. Interested students from surrounding schools arrive together in the afternoon to test programs they have written themselves or to puzzle out assignments that go beyond the requirements of their courses in data processing. And experienced technical people are often to be seen working at the computers as well, since in many areas the classroom equipment is also being used by adults preparing for qualifying exams. The effect is twofold: the computers are being used to capacity for many more hours a day, and at the same time an increasing number of people are familiarizing themselves with this key technology.

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BULGARIAN SCIENCE ACADEMY RESEARCH ON LASERS

Sofia SPISANIE NA BULGARSKATA AKADEMIYA NA NAUKITE in Bulgarian No 3, 1986 pp 17-24

[Article by Senior Science Associate Nikola Subotinov: "Laser Physics and Equipment in the Bulgarian Academy of Sciences"]

[Text] Quantum electronics is an area of physics examining the methods of amplifying and generating electromagnetic radiation in thermodynamically imbalanced quantum systems. The best known devices based on quantum electronics are masers and lasers. For this reason in the narrow sense of the word it is possible to speak about quantum electronics as the science of masers and lasers. Masers are quantum amplifiers and generators of coherent electromagnetic radiation in the radio frequency range while lasers are in the optical range (infrared, visible and ultraviolet areas of the spectrum).

Modern quantum electronics encompasses a colossal area. Arising in the area of radio physics, it has made the most substantial changes in the area of optics. The problem is that although the operating principles of lasers and masers are the same, the difference between them is substantial. In the radio band the development of masers has meant the appearance of devices which are new in terms of operating principle but also have the properties which are the usual for classic radiophysics. Undoubtedly masers sharply improved the parameters of radio devices, with their sensitivity and stability increasing by a magnitude of from two to three. The importance of these achievements for the radio band is great, but in principle this is a quantitative change in the known qualitative properties, since prior to the appearance of quantum electronics in radiophysics there were coherent radio amplifiers and radio oscillators of monochromatic oscillations.

The question is different in the area of optics. There, in opposition to ordinary electronics, all sources in terms of their nature are quantum. Prior to the appearance of quantum electronics, all optical sources of light emitted non-monochromatic and non-coherent oscillations. In optics we do not have coherent amplifiers and monochromatic oscillators of electromagnetic oscillations. Only lasers, in contrast to ordinary sources of light, emit light waves with high spatial directivity, spectral monochromaticness and time coherence. This is why the appearance of lasers has given optics the previously unknown opportunity to concentrate the radiation energy in space, in time and in a spectral interval. Precisely this raises optics to a qualitatively new level which is characterized by the development of applications in areas which are traditionally not optical. These new areas of application have become possible only due to the fact that in modern optics the effect of stimulated radiation is employed directly for generating light according to the methods of quantum electronics. Quantum electronics provides new opportunities for optics, in preserving its fundamental concepts.

The development of laser sources, their modernization and the mastery of new wavelength bands represent the physical basis of quantum electronics. At present, lasers operate in a broad band of wavelengths (from the submillimeter to the ultraviolet) under continuous and pulsing conditions. There is also an enormous diversity of different types of lasers for which there naturally is a corresponding diversity of active laser media and physical phenomena utilized for their excitation.

At present, 25 years after the starting up of the first laser, a large number of laboratories throughout the world are improving the known types of lasers and developing new ones which operate in various frequencies and have enormous power. If we were to attempt to systematize the present, already rather large family of laser sources according to three main characteristics of power, wavelength and radiation divergence, an impressive picture would be obtained of the rapid development of laser physics. From an object of physical research, lasers have been turned into a powerful tool of scientific and technical progress.

I. Areas of Research Activity at the Bulgarian Academy of Sciences

The Bulgarian Academy of Sciences [BAN] is the main scientific organization involved with the development of laser physics and equipment in our country. Research in this area commenced in 1962 at the BAN Physics Institute. The first Bulgarian laser based on a ruby crystal was put into operation in 1964 at the BAN Electronics Institute by Senior Science Associate V. Stefanov. Since that moment rapid development of research activities commenced in the area of laser physics in Bulgaria. At present, the main organizations of the BAN working in this area are the Electronics Institute, the Institute for Solid State Physics, the Laboratory for Applied Physics at Plovdiv and the Central Laboratory for Optical Recording and Processing of Information. All of these are under the Unified Physics Center. The historical development of quantum electronics has also been reflected in the organizing of work in this area at the Unified Physics Center. Laser research activities are concentrated chiefly around two main areas which gave rise to laser physics: radiophysics (at the Electronics Institute) and optics (at the Institute for Solid State Physics). Research at the BAN is of a fundamental and scientific applied nature. The fundamental research is involved with studying and mastering the phenomena which determine the operating principle of the laser active media, the methods of excitation and interaction of intense electromagnetic fields in the optical range with transparent and non-transparent media. The applied scientific research is closely tied to the fundamental results. This has led to the development of laboratory models of laser sources and systems with the possibility of a practical application as well as a study of the diverse areas for the application of lasers.

In this area scientific research is also being carried out at the Institute for General and Inorganic Chemistry Under the Unified Chemistry Center and this is aimed predominantly at the various types of production methods for growing laser crystals.

The scientific research activity in the area of laser physics and equipment at the BAN have the following main aims:

1. The development of new laser sources. In this area they are working to find new laser transitions in various types of active media. Of particular interest is the development of laser sources which generate in the ultraviolet area of the spectrum.

2. The improvement of known laser sources. Here there is an extensive field for scientific research activity. Here the work is related predominantly to improving the energy characteristics of the lasers, improving efficiency, the stability of the generated frequencies, the simplifying of design, reducing divergence and so forth.

3. The further development of known lasers. In our nation for certain more specific applications we need unique laser sources which in principle are better known and are produced by other countries. Specialists with good technical training can quickly reproduce and begin operating such lasers. This activity is of an applied nature.

4. Research related to the application of lasers. All areas of laser application are tied to profound studies in the area of optics, solid-state physics, spectroscopy, chemistry, biology and so forth. A study of the interaction of laser radiation with various media, its propagation, absorption and dispersion, provides a clear understanding of the various possibilities for the practical application of laser physics.

5. The development and production of laser systems. The developed laser sources have practical value chiefly when they are built into system which form specific tasks. The Unified Physics Center, is developing and manufacturing unique laser systems with the possibility for employing it in metering equipment, medicine, biology, technology and so forth.

The scientific research activities in the area of laser physics and equipment at the BAN make it possible to disclose great opportunities for satisfying our nation's needs for unique laser equipment. On the other hand, these laser sources and systems for which there is a proven greater need must quickly be put into mass production at our organizations specialized in these activities.

II. Research Tasks in the Area of Laser Physics and Equipment and Their Application at the BAN

1. Research on Laser Sources

1.1. Methods of Researching Certain Active Media for Gas Discharge Lasers.

The basic direction in this research activity is to determine the different characteristics of the active laser media: the occupancy of the energy levels, the effective relaxation time of the excited states, the amplification and absorption factors, and the cross-sections of the processes of excitation and deactivation. This research is essential to optimize the laser medium and, on the other hand, provides an opportunity to discover other laser transitions. A study is being made on magnetooptical, polarization and other resonance methods. For correctly interpreting the obtained results, the experimental research is supplemented by theoretical studies of the complex processes occurring in the active gas media. Particularly useful in this research activity is the magnetooptical method which has been worked out theoretically and proven experimentally for determining the occupancy ratios of the laser levels. The study of polarization signals is a prerequisite for determining the excitation possibilities of stage laser systems.

1.2. Inert Gas Lasers.

The basic portion of work in this area is aimed at discovering new possibilities for improving the performance of the helium-neon (He-Ne) lasers. It has been established that an He-Ne laser with a hollow copper cathode operates more efficiently than the hollow-cathode He-Ne lasers known from the literature. The reason for this is the greater occupancy of the metastable helium level 2^1S_0 and the upper laser neon level $3S_2$. The practical result from this research has been the obtaining of single-frequency generation at optimum power but without the application of selecting elements in the laser resonator.

With a change in the parameters of the conventional He-Ne laser and the application of an axial magnetic field a high conversion factor has been obtained for multifrequency laser power into single frequency having a value of 0.85 for a medium-sized laser. The developed single-frequency He-Ne laser can be employed for interference measurement of lengths, vibration and deformation, in Doppler anemometry, metrology and so forth.

As a result of years-long research activity on the He-Ne lasers a production method has been developed for long-lived lasers with a power from 1 to 10 megawatts. These methods have been introduced under factory conditions for mass production of such lasers in Bulgaria.

Research is being carried out to obtain laser generation in a mixture of inert gases for other wavelengths.

Quasicontinuous generation has been obtained in the helium-krypton and helium-argon mixtures in the blue area of the spectrum in a discharge in a hollow cathode. This research is aimed at developing new laser sources in the shortwave area of the visible spectrum.

1.3. Molecular Lasers.

Theoretical and experimental research is being carried out on conventional type lasers employing carbon dioxide. Data have been obtained on the influence of impurities with a low ionization potential on the plasma and generation characteristics of this type laser as well as on the kinetics of the processes occurring in them. On the basis of the obtained results, a range of CO_2 lasers has been developed and manufactured with an initial power of 50, 100, 150 and 400 watts radiating in a continuous mode. Two such lasers have been introduced in the system of the Ministry of National Education.

Important theoretical and experimental results have been obtained from research on the influence of various factors (for example, impurities, the capacity of the shaping capacitor) on the generating characteristics and processes of creating the population inversion in a pulsed CO_2 laser with ultraviolet preionization. An extensive range of experimental research has been carried out on pulse CO_2 lasers utilizing plasma electrodes. A CO_2 laser with two plasma electrodes with a large aperture has been developed. A laboratory model has also been developed of a TEA CO_2 laser with a pulse energy over 5 joules, a pulse power greater than 30 megawatts and a pulse repetition rate of 1 hertz.

The developed CO_2 lasers are the basis for extensive theoretical and experimental research on the interaction of strong infrared radiation with dielectrics and metals. Original production methods have been developed for cutting glass cylindrical articles by melting and controlled thermoseparation. The developed laser system for cutting a glass cup using the melting method has been introduced in the system of the Quartz Economic Association.

For the needs of laser spectroscopy, various modifications of nitrogen lasers have been developed and these radiate in the ultraviolet area of the spectrum. For developing the shorter wavelengths, research has been carried out involved with the development of eximer lasers based upon unstable molecules (for example, XeCl, KrF, KrCl and others).

1.4. Metal Vapor Lasers.

Metal vapor lasers are comparatively new and little studied sources which provide the possibility of generating a large number of lines in the ultraviolet, visible and infrared area of the spectrum. The experimental and theoretical research carried out has been on continuous operating and pulse operating lasers with metal vapors.

The continuously operating lasers generate in the ion and atomic transitions of the metals. A study has been run on the helium-cadmium, helium-selenium, neon-thallium, helium-copper, helium-zinc and other types of lasers. The conditions have been studied for a laser effect in a positive discharge column, a discharge in a hollow cathode and a high-frequency discharge. A new design of hollow-cathode laser has been developed with a spiral hollow cathode and this makes it possible to obtain stable laser generation with high discharge currents and voltages. As a result of the conducted research, a multicolored laser source which emits white light has been developed.

Of the pulsed lasers with autolimited transitions, a laser with copper bromide vapor has been a matter of research work. This laser is an original Bulgarian development which has been patented in a number of countries. It is a new version of a copper laser with a simpler and easier design for operating. The copper bromide vapor laser generates in the green and yellow area of the spectrum with an average output power of from 3 to 15 watts and an efficiency which reaches up to 1 percent. A lifetime of the laser tube of 1,000 hours has been achieved. A strong increase in the output power and efficiency of the laser source has been established with the addition of an admixture of hydrogen. The practical result of the research activities in the area of metal vapor lasers has been the development at the BAN of the production of single examples of helium-cadmium lasers and copper bromide vapor lasers. An unique laser microscope has been developed based upon the copper bromide laser. The microscope has a magnification of 10^4 times and produces an image of the microobjects on a large screen with a diameter up to 2 m. The laser microscope will be employed in microelectronics, biology, medicine and so forth.

1.5. Tunable Lasers.

The main results are in the area of tunable lasers with liquid active media based on dye solutions. The main scientific results can be grouped in two areas.

The first relates to new methods and ideas for controlling the spectrum of the laser sources and for stabilizing the generated frequency. Here the most substantial contributions are: the obtaining for the first time of a reflected interference wedge for spectral control of laser generation; the proposal and realization of new frequency tunable lasers with two independently or concomitantly tunable frequencies; the finding of new methods for generating frequency stabilized laser radiation with tuning.

In the second area fall the physical-technical research related to optimizing the energy characteristics of the generation of active media on the basis of the dye solutions as one of the most active media for creating tunable lasers with broad-band tuning. The scientific research and applied developments have been aimed at creating new efficient tunable lasers for application in laser detection and ranging, high resolution spectroscopy and for developing unique scientific instruments and systems for solving problems of scientific research practice.

On the basis of the research work and original scientific results, unique scientific instruments have been developed such as, for example, tunable lasers with varying pulse energy, an electrooptical compressor of laser pulses and so forth.

2. Research in the Area of Laser Spectroscopy

One of the major applications for laser equipment in scientific research is laser spectroscopy. In this area the BAN is carrying out research chiefly in two main areas.

The first area encompasses laser photophysics, photochemistry and photobiology of nucleic acids and their components. The work here is aimed at studying the primary and terminal stages of the direct and photosensitized effect of strong ultraviolet radiation on nucleobases, mono- and polynucleotides, DNA, chromatin and cell cultures. Methods have been developed for selective photomodification of DNA and its individual sections as well as for inducing certain specific modifications such as dismembering the chain and joining the DNA protein. A study is also being made of biostimulation (photoinduced mutations in macroobjects such as seed, pollen, cell cultures and so forth). For carrying out this research a specially developed laser picosecond spectrometer is being used consisting of a picosecond YAG laser with passive mode synchronization, two-stage amplifier, a frequency tuning system and a recording system. With the laser picosecond spectrometer a time separation of 10^{-11} seconds has been achieved as well as the wavelength tuning from 0.35 to 1 micron with a pulse energy up to 60 millijoules.

The object of the second area is laser spectroscopy of highly excited states in multielectron systems. In this area we are investigating the spectral properties of highly excited states in complex atoms (in particular, rare-earth). Methods have been developed for the detection and analysis of microquantities of the elements in fluid and solid samples with a detection point of 10^{-10}-10^{-12} percent. This is of particular importance for geology, oceanology, medicine and biology, for the production of superpure substances, for environmental conservation and so forth. Theoretical models have been developed for calculating the spectra of highly excited states. Experimental research is being carried out employing the method of selective excitation and ionization of atoms. A laser analytical photoionization spectrometer which has been specially developed for this purpose is being employed. This makes it possible to achieve a separating capacity up to 0.03 cm^{-1}, a sensitivity of 10^{-10}-10^{-12} percent and an impurity in a real sample with maximum time separation of 7 nanoseconds.

3. Remote Sounding of Atmospheric Parameters

Work in this area is tied to the development and improvement of methods for lidar probing of atmospheric characteristics. The theoretical research has provided integrated analytical descriptions of the lidar -- atmosphere system with quantitative estimates of the lidar noise, the forming of requirements for the parameters of the lidar units, the elaboration of the algorithms, programs and means for processing the lidar information. On the basis of the theoretical research, lidar systems have been developed with extensive functional capabilities, for example, the measuring of the remote profiles of air current speed, of the aerosol content of the atmosphere, atmospheric transparency, air temperature, the concentration of certain atmospheric gases and the height of cloud fields. The developed lidars can be employed in systems of long- and short-term meteorological forecasting as well as in measures related to the monitoring and conservation of the environment.

4. The Development of Unique Laser Systems

The developed laser systems are chiefly for the needs of medicine, biology and spectroscopy. The laser system for medical and biological research has concrete application for brain research. The system comes with stereotaxic devices for fixing the center of the brain with an accuracy under 1 mm and a manipulator for delicate movements of the objects with an accuracy of 0.1 mm. The master laser oscillator is capable of emitting two wavelengths of 0.69 micron and 1.06 micron, with smooth tuning of the output energy and operating frequency of the system. The development is employed for tracing the paths of the central nervous system and the connection between the brain and the spinal column.

We have also developed the biophysics I laser system which is designed for research on the biological effect of radiation on plant cells and macroobjects and a laser system for emission microspectral analysis. The two systems have been put into actual use.

The laser acupuncture systems LT001, LT002 and LT003 have been developed for the needs of medicine. A large portion of these is exported to the capitalist world.

5. Elements of Laser Equipment

All the scientific and applied scientific activities in the area of laser sources and systems are tied to the development of the hardware. Although with small capabilities, the BAN has developed a number of optical elements used in laser equipment. We are manufacturing laser booster windows of different sizes, glass backings for laser mirrors, prisms and lenses of differing sizes and focal lengths. For the first time in the nation, the BAN has developed the production of multilayered dielectric laser mirrors. On the basis of advanced production methods we are manufacturing mirrors with high reflectivity for the visible, infrared and near-ultraviolet area of the spectrum. We have developed interference filters with a half-power width of the pass curve reaching several angstrom. In addition to passive elements we are also developing and producing active laser elements for control of the laser beam. Of particular interest are the developed modulators based on the interference principle. These realize high-quality transmission of a television signal over a laser channel. Research is being carried out on various new elements for the needs of laser communications such as light guides, couplings, breakers as well as integrated-optical elements.

Of great importance for the development of solid-state laser sources in our nation is the development at the BAN of equipment for growing laser crystals. With the aid of this technology, crystals are being manufactured from yttrium-aluminum garnet with admixtures of neodymium. The crystals are up to 160 mm long and 18 mm in diameter. They possess good optical qualities making it possible to obtain a low generation threshold. As an active medium of Nd we are using the YAG lasers. In addition to this type of crystal, we have also mastered the production methods for YAG crystals with an admixture of erbium and holmium. This provides the possibility of designing new types of solid-state lasers which generate in the ions of rare-earth elements.

* * *

The scientific research activities of the BAN in the area of laser physics and equipment are concentrated on some of the most important problems on which many scientific centers throughout the world are at work. A number of substantial scientific results have been obtained and these have been recognized outside the frontiers of our nation. The BAN collaborates in the area of quantum electronics with similar strong organizations such as the Physics Institute and the Institute for General Physics Under the USSR Academy of Sciences, the Novosibirsk Division of the USSR Academy of Sciences, the Polish, Hungarian, East German and Romanian Academies of Sciences. The ties of the BAN scientific workers with scientists from the socialist countries have made it possible to quickly and effectively resolve the posed problems.

The work of the BAN in the area of laser physics is being aided by the Chair for Quantum Electronics Under the Philological Faculty of the Sofia Kl. Okhridski University. Many of the young specialists who are well trained there quickly join the research activities of the BAN. The academy is closely tied to the activities of the development-introductory institutes in our country. Over 40 problems of the BAN in the area of quantum electronics have been incorporated in the National Program for Opticoelectronics and Laser Equipment to be carried out during the following five-year plan. Many of these problems are of an applied scientific nature and will end with an introduction for practical needs. These activities make it possible for the highly skilled scientific workers to take an active part in this strategic area of our science. The employment of laser equipment in the national economy will lead to the mastery of the most advanced production methods in machine building and chemistry and to a qualitatively new stage in communications and medical technology. The use of lasers in science places scientific research in the area of biology, physics and chemistry in our nation on a new, much higher level.

10272
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TRANSACTIONS, CONTACTS AT POZNAN (POLAND) FAIR

Warsaw PRZEGLAD TECHNICZNY in Polish No 32, 10 Aug 86 p 12

[Article by Marek Przybylski: "We Are More Visible"; the lead paragraph is printed in a large type]

[Text] What I am going to say is not just my personal opinion but a generally held view: the recently completed 58 MTP [58th International Fair in Poznan] was an extraordinary event which just could mark a breakthrough in our foreign trade.

This high appraisal of the fair results not only from what has been done for this event by the organizers of MTP but is primarily a result of important developments which coincided in time with the Poznan fair. I am referring to Poland's recent rejoining of the International Monetary Fund. The pertinent document was signed by the minister of finance on 12 June 1986 in Washington. Poland has become the 151st member of the fund. Our country undertook to contribute to the fund $795 million, including 25 percent in hard currency. This entitles Poland to borrowing from IMF amounts that are four- to fivefold the membership contribution.

These credits are available at a considerably lower interest rate than financing from private banks. In addition, the membership in the fund enables Poland to apply for credit at The World Bank for long-term financing of economic projects. This is also a confirmation of our creditworthiness in the eyes of private banks.

An important reason for the lively interest in this year's MTP shown by Western companies was the approval in April 1986 of the decree on cooperative enterprises with foreign participation. Like other socialist countries, Poland became a nation allowing direct participation of foreign capital in the national economy. The new legislation raises many hopes and opens prospects for the development of cooperation with foreign countries. This was emphasized at discussions at the Polonia Economic Forum, which preceded the fair.

Importantly, the total area of the current fair (127,000 m^2) was larger than last year's. More important, however, is that sales to foreign firms amounted to a higher percentage. On the limited territory of the fair there were about 2050 representatives of companies from 39 countries, including 1700 from Poland. These numbers are an indicator of interest in our economy and trade with Poland.

My conversations with exhibitors from capitalist countries confirmed the growing interest in trade with Poland. Virtually all of the representatives I spoke with felt that there are currently more favorable opportunities for cooperation. I was told that these companies offer credits for the development of the Polish industries with which they cooperate. This includes, in particular, our cable industry and optical industry. Credits for these industries will come, among other sources, from Switzerland and France.

The head of the exhibition of the large Swiss concern Merona, Stephan Dobrit, offered an interesting description of his cooperation with Poland. His company has been an exhibitor at MTP for years and came to Poznan not only in periods of favorable economic climate but when it was worse. He says that only such long-term uninterrupted trade breeds mutual trust. Merona has been exceptionally active in contacts with Poland. Last year, for example, negotiations were completed with success on the sale to Poland of electronic technology; our customers will pay for this equipment in rubles. On this basis Metronex and Elwro will purchase equipment for more than 11 million rubles. Merona is already using this form of settlement in its contacts with Czechoslovakia, Hungary and Bulgaria. Recently, Merona has sold to Poland special machines for production of printed circuits. The firm also buys from Poland various electronic subassemblies and this year plans to extend credits to Ciechow for purchase of chemical raw materials. Cooperation with our cable industry has been developing successfully; the firm supplies it with polyvinyl chloride and purchases finished cables on a large scale. It is also making use of Polish experts, employing them for solution of various problems. The Swiss emphasize their appreciation for the expertise of Polish engineers.

Lubricants and oils, presented in Poznan by the Austrian firm Kluber Lubrication, were products of top world quality. The head of the delegation, Horst Praschinger, reminded that for many years his firm has been a partner of the Polish fiber industry, metallurgy, foundries, shipbuilding, refrigeration industry, ceramics and food industries. Although in the past few years the amount of trade with Poland has somewhat shrunk, the presence of this firm in our markets is recognized as indispensable. We have thousands of consumers who want to buy not only special types of lubricants and oils but who are avid recipients of all kinds of technical information in the technology of lubrication. The company does not merely sell its products in our markets but takes part in scientific and technical symposia; recently it participated in the conference marking an anniversary of the Metal Casting Institute in Krakow. The city government of Poznan became interested in business contacts with the firm. At a meeting with Poznan mayor Andrzej Wituski, the representatives of the firm discussed the possiblity of arranging in Poznan a symposium on traffic engineering. This subject could be of interest for industrial managers, as well as for Poznan city services, and particularly for tramlines and the rapid tram system being constructed. The subject is of interest not only for public transportation in Poznan but for other cities in Poland as well. The symposium will probably take place in the fall.

Finally, a few words about contacts. After all, they are the main objective of each fair. The final results are not yet known, but it has been determined that the total amount of sales has already exceeded 161 billion zlotys, including 112 billion for exports. This amount does not include $100 million or the amount of contracts signed by Dal Enterprises with the British firm Goodwood. A total of 140 billion zlotys accounts for the contracts signed with socialist countries. The largest share is with the USSR (60 billion zlotys). A dramatically high sales figure has been achieved in contacts with Czechoslovakia (42 billion zlotys). Among capitalist countries the leading place belongs to the FRG, followed by Japan, Switzerland, Sweden, Austria and Belgium. Many contracts have also been signed with Yugoslavia.

Partially, the trade contracts are a continuation of good results obtained by our foreign trade at the beginning of this year. In the first five months we exported to capitalist countries 9 percent more than the year before. In turn, the imports increased by 13 percent. Importantly, the share of electrical engineering products in the exports has risen by 33 percent. This is a highly desirable change in the structure of exports.

All these are positive phenomena. It must be emphasized, however, that these symptoms of improvement are observed against the background of a low level as compared to our needs and capabilities. It should be borne in mind that in 1938 Poland's exports amounted to 1 percent of the world's total. In the record 1970's it rose to 1.1 percent. Currently, Poland's exports amount to 0.6 percent.

While observing the signs of definite improvement, it should be remembered that we are still at the beginning of the road leading to recovery of our lost position. This is the context in which one should see the recently completed most important event of Poland's foreign trade this year. 58 MTP was an illustration of the new interest in Poland as a partner of international division of functions and also a sign of a still low level of Polish participation in foreign trade--a factor which many nations have successfully used as a powerful tool of progress and continued improvement of their standard of living.

9922
CSO: 2602/3

EAST EUROPEAN POST-CHERNOBYL NUCLEAR CONSTRUCTION

Hmaburg DIE ZEIT in German No 42, 10 Oct 86 p 34

[Article by Karl Stipsicz: "Into the Nuclear Age with No Doubts"]

[Text] "We cannot permit Yugoslavia's neck to be placed in a dangerous noose with the construction of the Prevtaka nuclear power plant." Prof Dragica Ivanovic, rector of the Technical University in Belgrade, is known across Yugoslavia as a resolute opponent of nuclear power plants. What is unusual is the site of his phillipic: the assembled Central Committee of the Yugoslavian Communist League.

Fear of the likelihood of failure was only a small link in the chain of argumentation presently so passionately by the professor. He stated that Yugoslavia was too deeply in debt to be able to afford the luxury of a nuclear power plant imported from the West. Moreover, he added, Yugoslavia's own dormant energy reserves of gas and hydroelectric power had been exploited far too little. The memorable Central Committee session took place before, not after, Chernobyl, on 20 February this year.

In some Western countries, the accident in the Ukraine, assumed to be the biggest ever, was needed in order to rouse the majority of the population against nuclear power. In the multiethnic nation of Yugoslavia, opinion pollsters were already calculating at the end of 1985 that there was a slim majority opposed to the peaceful use of nuclear power.

In the meantime, the government in Belgrade had proposed ambitious nuclear program: by the turn of the century, another four 1000-MW nuclear installations were to be constructed, in addition to the 660-megawatt power plant in Krsko on the border of the republics of Croatia and Slovenia. Companies from eight Western nations and the Soviet Union were interested in the gigantic contract. Chernobyl has substantially reduced the nuclear power plant constructors' chances.

In the last days of July the government in Belgrade decided to postpone their nuclear plans for the time being. Instead of the foreign proposal, the intention is to study in the fall the draft of a committe of experts, which was assigned the task of including all available domestic reserves in an alternative energy plan. At the focus of the Yugoslavian nuclear debate is the question whether burning low-grade brown coal from the Kossovo region and a system of dams on the Drina can take the place of electricity generated from nuclear power.

The cold winters and dry summers of the past few years would be be in favor of the nuclear lobby in Belgrade, which can draw support, not from environmental majorities, but from discouraging energy reports. The country has to import about 12 million tons of crude oil annually. The expensive raw material is shipped from the Gulf region to Yugoslavia, but the bill comes from Moscow. As part of a three-way trade, Soviet goods are exported to the Arab countries; in exchange the recipients send oil to the Adriatic, and Belgrade transfers hard currency to the Soviet Union, which in this way saves itself the expense of transportation and the construction of an oil pipeline.

The degree of dependency on the superpowers is still a touchy question in non-aligned Yugoslavia. For the opponents of nuclear power, who have their allies even in the higher ranks of the party, expanding the derivation of energy from nuclear power plants is synonymous with greater dependence--this time from the multinational concerns and creditors of the West. Now, according to opinion polls, three out of four Yugoslavs are firmly opposed to nuclear power.

In the socialist states of central and eastern Europe, the nuclear energy question never came up following Chernobyl. In the CEMA countries, ironic observation of Soviet technology is part of the almost 40-year tradition of Communist jokes. While the Czech media carried only very tentative reports about the Chernobyl catastrophe, Polish and Hungarian newspapers were painfully accurate in their explanations in following the critical articles of their Soviet journalist colleagues.

The Eastern Europeans' caution is rooted in decades of experience. Openly expressed criticism of the products of Soviet industry is easily interpreted as an expression of disloyalty toward their power ally. At the same time, their own nuclear program would be put in question, because all the Eastern countries, with the exception of Rumania, are implementing their energy plans with the help of Vorenesh model pressurized water reactors. When the radio-active clouds from Chernobyl were still floating over Europe, socialist nuclear experts hastened to explain that the Voronesh installation was, first of all, constructed quite differently from the reactor involved in the accident in the Ukraine, and second, that their own nuclear power plants were surrounded by additional protective walls (containments) and were therefore especially safe.

Protests only in Poland

This line of argument still holds today. Chernobyl is considered to be an exception, which has no bearing on East European reality. Small protest marches were held only in Poland, which, as the neighboring country to the Ukraine, was much more severely affected than the other European countries, and letters were written to the Sjem, the Polish parliament, and even answered. The chairman of the parlimentary committee for science and technical progress assured about 3,000 citizens of Bialystok, who had demanded an end to the

Polish nuclear program in a petition, that "all the experiences of Chernobyl would be considered in the construction of our own nuclear power plants." In the first weeks of May, government spokesman Jerzy Urban announced that there would "not be any alterations in the plans already decided upon." The first Polish nuclear power plant at Zarnowiecz (Zarnowitz) is currently under construction, with the guidance of Soviet engineers, and is supposed to start operation in 1990.

The rather timidly presented protests of Polish doctors and the affected citizenry carried absolutely no weight in the decisions of the economic bureaucracy. On 16 July--the accident at Chernobyl happened just 11 weeks earlier--the schedule of deadlines was published for the construction of a second Polish nuclear power plant. In 1995 the first of a total of four 1,000-MW light water reactors is supposed to start operation near Klepicz in the Posen Bezirk--200 kms from Berlin.

The worst enemy of the Polish nuclear program is their own sloppiness. The management of the construction at Zarnowiecz was criticized in an article in the trade paper PRZEGLAD TECHNICZNY: Only 2,200 of the 4,000 employees came to work on time, deliveries were not on schedule, and far too little construction equipment was being used.

The Czechs and the Slovaks are making more decisive plans to switch to the nuclear age. No other country carried such brief and such modest reports about Chernobyl as the CSSR. On 30 April the Communist party newspaper RUDE PRAVO denied reports which said that increased levels of radioactivity had been measured on Czechoslovakian territory. Six days later, however, state television announced that "radioactive radiation in the country" had "already declined by one third." In official parlance, Chernobyl was played down as a "regrettable operating accident in rapid scientific-technical development."

Like France, Czechoslovakia has tailored its energy plans totally to nuclear energy. In the year 2000, 60 percent of the total electricity generated is supposed to come from nuclear sources. Last year the five 440-MW reactors in the country generated 14.6 percent of the electricity, this amount is supposed to be almost double by 1990. But even energy experts in Prague consider delays in this ambitious program to anywhere from "possible" to "probable." Unofficially, organizational shortcomings as well as a planned retroactive technical safety measures for all nuclear plants under construction and in operation are being made responsible. Newly awakened concern about safety is costing hard Western currency, because the appropriate systems have to be imported from the FRG or France. In the country itself, only the dissidents of the civil rights movement Charta 77, who are largely isolated from their fellow citizens, are protesting against the nuclear plans.

There is no alternative for the energy planners in Prague to their ambitious nuclear program. The devastating diebacks in the forests, which have turned wide areas of the Erzgebirge and the Bohemian Woods into pilgrimage sites for concerned forestry experts from around the world, make nuclear power appear to be the lesser evil to many Czechoslovakians. According to the 5-year plan, consumption of coal and crude oil must not increase until 1990.

Manufacturers' Fears

The Chernobyl disaster has another, unpleasant side for the CSSR. Within the socialist economic community CEMA, the Czechs have been assigned the role of manufacturer of reactors. In the Pilsen Skoda factory, 3 reactors are built each year--Hungary and Poland are each supposed to receive 4, 3 are destined for the GDR, and 10 440-MW reactor blocks are to be set up in Czechoslovakia. The fears in Pilsen are now that the grandiose expansion plans of the CEMA states could be drastically curtailed, which in turn would affect Czech exports of machinery and the country's laboriously maintained full employment.

The fears of the Bohemians were initially confirmed in a resolution passed by the government in Budapest: Hungary's nuclear program is, for the time being, restricted to the expansion of the only existing nuclear power plant at Paks on the Danube. In 1987, every fourth kilowatt-hour of electricity is supposed to be fed from Paks into the Hungarian grid.

Hungarian environmentalists, who have been fighting for years against a power plant which is under construction on the Danube 40 kilometers above Budapest, hardly uttered a word on the topic of Chernobyl. Hungarian opponents of nuclear power are short of arguments, even more than their like-minded colleagues in Poland and Yugoslavia: Their country has practically no energy reserves. As a direct consequence of the Soviet nuclear accident, the Hungarian government intends to adopt FRG safety regulations for nuclear power plants and consult Western specialist companies on questions of safety.

Eastern and Western experts are united in their perplexity about how energy management should proceed following the Chernobyl catastrophe. A Hungarian nuclear physicist answered the question about the direct consequences of Chernobyl with a suggestive smile: "The world may have changed, but our alternatives remain the same."

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