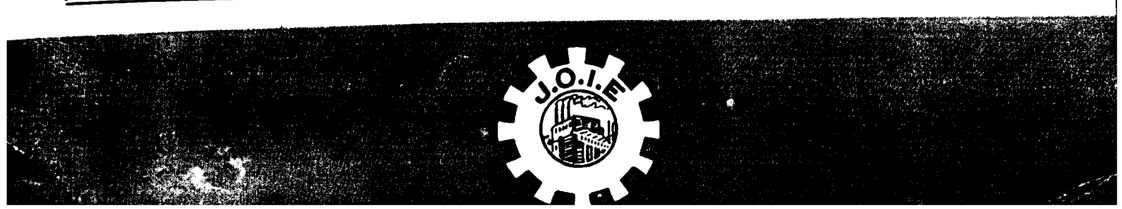
JOURNAL OF INDUSTRIAL ENGINEERING

ANNUAL NUMBER



Journal of Industrial Engineering

Vol. 3 No. 1 SEPTEMBER 1958

Rs. 3.50 (INDIA)
Rs. 5.00 (OVERSEAS)

CONTENTS

FOREIGN EXCHANGE PROBLEM

THE foreign exchange position, which had appeared to have eased a little only a few months ago, has again hit the headlines. It has taken a turn for the worse. The country is now absolutely hungry for foreign exchange.

The drain on the Reserve Bank's foreign assets has been proceeding at an alarming rate. The weekly drain works out to Rs. 6 crores to Rs. 7 crores. At this rate it is doubtful if the reserve will see us through to the end of this year. We can carry on for some time more, by again reducing the minimum currency reserve requirement, but even this dangerous measure will give us only a short breathing space.

Of course, it should be admitted on all hands that any country trying to implement a huge programme of industrialisation, as our country is doing, cannot avoid such problems. But it cannot be denied at the same time that the problem would not have assumed such serious proportions, had a little more foresight been exercised and a proper care taken two years ago when foreign exchange resources were frittered away on importing comparatively non-essential items.

The inevitable thing has happened. Imports have been drastically curtailed with the result that the efficiency of industry generally is being adversely affected thereby helping to postpone a return to solvency.

New export lines for closing the gap between imports and exports are not making much progress. This is because of high prices resulting from the high level of taxation and efforts being made by almost every country to sell as a result of the recession. Moreover, there is severe competition in regard to both traditional export items as also other commodities. The recent move of the Government to grant tax reliefs to some exporting industries may go some way towards strengthening their competitive position. But still there is enough room for doubt whether it would be possible to achieve the target of increasing the exports within the next six months to the extent of Rs. 50 crores as laid down.

The Indian industries to-day are keen enough to keep their wheels turning round, their workmen fully employed and to do their share in providing at least some of the much needed foreign exchange, but in the context of what has been stated above, further curtailment of imports may not be avoidable. But as rightly pointed out by the Governor of the Reserve Bank of India, Sri H. V. R. Iyengar, this would be self-defeating, since the process of development itself might be brought to a grinding halt by a severe reduction in the imports of machinery and capital equipment.

Already drastic cuts in imports have produced their adverse effects on the country's economy. Production has been slowing down in some vital industries for the dearth of essential raw materials and components for which the country has to rely on imports. This, in its turn, has resulted in the displacement of labour force from units which threaten closure, partial closure or closure of shifts, thereby further aggravating

the unemployment situation. The case of industries depending on the supply of stainless steel as their raw material, may be cited as an instance in point.

The only relieving feature of the whole thing, however, is that the difficulties of our country, are being sympathetically viewed by friendly countries. The possibility of getting long term credits is bright especially in view of the recent move in the American Senate to increase the amount of loan promised to India. Other countries like U.S.S.R., U.K., West Germany, etc., where a good deal of unused industrial capacity exists, are also expected to come to our help. But then what about repayment ?

One way is of course to cultivate trade relations with them and help them to understand that the only way in the long run, by which they can get payment for the goods they send us, is to welcome our goods into their market in exchange.

And for this purpose, there must be a halt in the fall in export earnings, the quality of products should be improved and the full utilisation of the existing productive capacity is to be insisted upon rather than setting up new industrial units unless unavoidably required. The stand of the Government should also be to encourage to a certain extent importing of even ' banned ' articles which could be utilised by indigenous industries to manufacture exportable goods.

STAINLESS STEEL FLIES HIGH—AND FAST!

*By *J. N. Barnett and **W. W. Rohde*

Development Engineering Department, Armco Steel Corporation, Middletown, Ohio.

ABOUT 45 years ago researchers first discovered the excellent corrosion-resisting characteristics of iron-chromium alloys. As early as 1915 steam turbine blades were being produced from an iron-chromium alloy very similar in composition to the present day Type 410 stainless steel, containing about 12% chromium. This material could be hardened by heat treatment to high strength levels and was considered a good corrosion resisting material for that period.

During the same period another alloy containing chromium and nickel was developed. This alloy was much the same in composition as the now standard AISI Type 302 stainless steel, and like Type 302, was not hardenable by heat treatment.

These two alloys were the forerunners of two fundamental classes of stainless steel. Shortly after their development a third basic class was originated that consisted of chromium, non-hardenable types of stainless steel.

WHAT IS STAINLESS STEEL ?

Although there are more than 50 standard analyses and types of stainless steel, all have one characteristic in common. They contain at least 11% chromium, which imparts the high degree of corrosion resistance for which the stainless steels are well known.

Other alloying agents are used to impart many different properties to the basic grades of stainless steel—nickel being the most common. The effect of alloying agents is shown in Table I.

THREE MAIN CLASSES OF STAINLESS STEEL

A convenient way to remember the characteristics of different grades of stainless steel is to group them into three main classifications—austenitic, ferritic, and martensitic. These are metallurgical terms defining the microstructure of the stainless steels, and almost every alloy falls into one of the three classifications.

The austenitic group is typified by AISI Type 302, commonly known as 18-8 stainless steel. This alloy has a basic composition of 18% chromium and 8% nickel. It is typical of the austenitic alloys that they are not hardenable by heat treatment, are most easily fabricated, and offer excellent corrosion resistance, toughness, and ductility. Typical applications for this group include chemical processing equipment, dairy and food handling equipment, and aircraft parts.

By changing the analysis of Type 302, often with the use of additional alloying elements, it is possible to produce other notable characteristics in the alloy. For example, Type 310 stainless steel containing 25% chromium and 20% nickel is often used as combustion tube liners in jet engines. This grade has an excellent combination of scaling resistance, plus high temperature, tensile and creep strength, all of which are essential in this service.

The ferritic grades are typified by Type 430 stainless steel, which has 17% chromium as its main alloying element. This class of stainless steel in some corrosive environments does not have quite the corrosion resistance of the chromium-nickel grades; yet it is satisfactory for many applications. For example, most of the bright metal trim on today's American automobiles is Type 430 stainless steel. Type 430 is also used where combinations of corrosion and heat resistance are required, such as in furnace oil combustion chambers, heat exchanger flues, and related uses. The entire ferritic group is characterized by being magnetic and substantially non-hardenable. As in the case of the other two classes, modified grades are produced by the use of alloying elements.

---

* Born in Indianapolis, Indiana, Jack N. Barnett was graduated from Purdue University in 1953 with a B. S. Degree in metallurgical engineering. For the past four years he has been a market specialist and product specialist on stainless steels in Armco's Market Development Division.

** Walter W. Rohde is a native of Baltimore. Served with U. S. Navy during World War II. Received B. S. in Engineering from John Hopkins University. Accepted position with Baltimore Rustless Division of Armco in 1950, transferring to the general offices in Middletown, Ohio, in 1955.

The third major group consists of the martensitic chromium alloys, which are hardenable by heat treatment. Typical grades include Type 410 (12% chromium), Type 420 (13% chromium), and Type 440 (17% chromium). In addition to the chromium

View of B58 "Hustler" showing 17-7 PH honeycomb panels. (Shaded area around elevons and aft section of jet nacelles)

content, carbon is added in varying amounts up to about 1%, which permits hardening to high hardness and strength levels. These materials are most widely used in the form of bar, wire, and forgings. They are fabricated into such products as surgical instruments, fasteners, screw machine parts, knife blades and similar parts requiring high strength, hardness, and corrosion resistance.

A summary of the characteristics and typical grades in each of the three classes of stainless steel is shown in Table II.

DEVELOPMENT OF PRECIPITATION-HARDENING ALLOYS

For many years steel research metallurgists saw the need for a stainless steel possessing the great toughness, corrosion resistance and workability of the chromium-nickel group combined with the ability to be heat treated to high strength levels like the chromium martensitic group.

In 1942, the Research Laboratories of Armco Steel Corporation decided to do something about it. Development of an easily worked material that could be strengthened to high levels by low temperature heat treatment got underway. After six years of intensive research, two materials meeting these requirements were made commercially available in 1948. These alloys were 17—7 PH and 17—4 PH stainless steels. They opened up a whole new field of metallurgy and applications in the stainless steel fabricating industries.

These materials are very tough and ductile as shipped to the manufacturer from the steel mill. This means they can be easily fabricated with standard equipment used in the metal working industries. Then, by simple low-temperature heat treatments they develop exceptionally high strength, as shown in Table III.

PRECIPITATION-HARDENING ALLOYS IN AIRCRAFT

With the advent of high speed aircraft and missiles following World War II, it became apparent that new materials were needed that would withstand the greater heat generated by high speed flight and the stepped-up power plants. Besides possessing high strength in relation to their weight, these materials had to retain much of their strength at elevated temperatures. Moreover, they had to be capable of being fabricated into finished assemblies by customary forming and joining methods.

The Armco precipitation-hardening stainless steels meet these requirements. Room temperature strength of 17-7 PH in the hardened condition (TH 1050) is equal to or higher than any of the standard stainless steels. Also, it retains a high percentage of its room temperature strength at temperatures up to about

Scene in Armco Research Laboratories showing new experimental aircraft alloy being processed on equipment that simulates actual steel plant rolling facilities. For test purposes, many such new alloys are rolled to the common thickness used for aircraft and missile parts.

800° F. This is why it quickly found wide usage for structural components in many of the jet airplanes

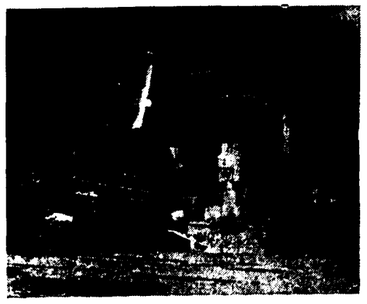
developed over the past nine years. It has been used for various parts in the F84F, F86, F100, F101, F102 and F104 fighter aircraft, in the B52, B58, P5M—1, and P5M—2 bombers, and in the IM99 Bomarc and other guided missiles.

Although the original precipitation-hardening alloys have performed admirably in many aircraft and missile applications, it soon became apparent that even stronger heat-resisting alloys would be demanded by aircraft design engineers. In anticipation of these demands, Armco research personnel developed a new precipitation-hardening alloy which was announced for commercial sale in September of 1957. Designated PH 15-7 Mo, the new alloy retains the ease of fabrication and good corrosion resistance of 17-7 PH, but offers much better strength at elevated temperatures. Moreover, it responds to the exact same heat treatments as 17—7 PH.

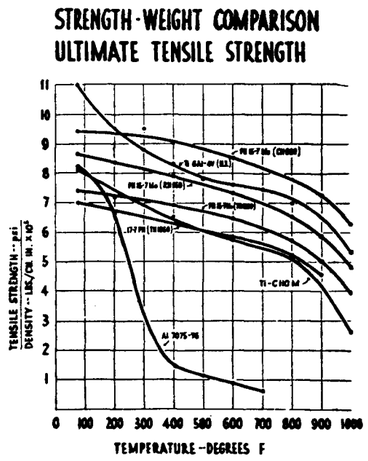
17-7 PH

The 17-7 PH alloy is unique among the stainless steels in that it combines the outstanding characteristics of the regular austenitic chromium-nickel grades with those of the martensitic chromium grades. In the as-shipped condition (Condition A), the alloy is very similar to Type 301 or 302 stainless steel. It is tough, ductile, easy to work, and highly corrosion resistant. Most forming and joining operations are performed while the steel is in this condition.

After forming, 17-7 PH parts are given a double-low temperature heat treatment that develops



This electric furnace at an Armco's Unit is being tipped to pour the molten stainless steel into a ladle beneath the floor. The pipe-like columns on top of the furnace are adjustable carbon electrodes that, when arced, provide the tremendous heat that melts the charge of special alloys.



exceptionally high strength in the alloy. The standard TH 1050 heat treatment and resulting properties are shown in Table III.

In order to meet the increasing demands of aircraft designers, Armco Research redoubled its efforts to obtain even higher strengths with 17-7 PH stainless steel. The result was a new heat treatment known as RH 950. The heat treating cycle and resulting properties are shown in Table III. In addition to higher strength, fabricating economies often can be realized due to easier removal of scale and ability of the material to be restruck in the original forming dies.

Highest possible strength is obtained in 17-7 PH by cold reducing in the mill to Condition C and subsequently heat treating to Condition CH 900. As shown in Table III, tensile strengths above 1/4 million psi are obtained in this condition of heat treatment. This makes the material ideal for spring applications made of wire and thin strip. The elastic properties are equal to or better than the best music wire and alloy spring steels. However, because of its high strength, the alloy has limited ductility that restricts sheet applications to flat parts or parts that require only very mild forming.

17-4 PH

In general, aircraft designers have looked to 17-7 PH stainless steel for applications requiring the use of sheet, strip, and plate. For applications requiring high strength stainless bar and billet, the companion

grade, 17—4 PH has been found most useful. Essentially, the major fabricating difference between these two alloys is that 17—4 PH requires only one low temperature heat treatment as compared to the two-step heat treatment of 17—7 PH.

Like 17—7 PH, fabricating is normally done in the solution treated condition (Condition A). The effect of various final hardening temperatures is shown in Table IV.

PH 15—7 Mo

From a design standpoint, PH 15—7 Mo differs from 17—7 PH in only one respect, but it is a major one. Because of its molybdenum content, the strength of PH 15—7 Mo is greater than 17—7 PH at both room and elevated temperatures. In long time service at temperatures of 800° F., for example, it is three times better than 17—7 PH.

With this additional strength, PH 15—7 Mo still maintains the other essential characteristics for many aircraft and missile applications—ready availability, ease of fabrication, corrosion resistance, and relatively low cost. A few representative properties of PH 15—7 Mo are shown in Table III and Figure 1.

ELEVATED TEMPERATURE PROPERTIES

Both 17—7 PH and 17—4 PH exhibit noteworthy elevated temperature properties. In the RH 950 condition, 17—7 PH has a typical ultimate tensile strength of 160,000 psi at a temperature of 800° F. Figure 1 shows how 17—7 PH compares with other commercial aircraft structural alloys on a strength-weight versus temperature graph.

The creep and stress-rupture properties of 17—7 PH and 17—4 PH are also significant. For example, the creep strength of 17—7 PH in Condition TH 1050 is 105,000 psi at 700° F. (stress to produce 0.1% deformation in 1000 hours). Stress to rupture at 700° F. in 1000 hours is 122,000 psi.

These favorable high temperature properties, coupled with the ability of the Ph alloys to be formed and joined easily with standard metalworking equipment, are the reasons why today the alloys enjoy wide-spread use in the aircraft industry.

FUTURE DEVELOPMENTS

As the speeds of aircraft and missiles go up, even better materials will be needed. To keep pace with the increasingly exacting requirements, Armco Research is continually investigating newer stainless alloys that show promise of meeting the design parameters of the future.

REFERENCES

1. Alcoa Aluminum Handbook—1957 edition.

2. "Titanium Engineering Bulletin No. 1," revised January 1957, Titanium Metals Corporation of America.

3. Data Sheet, "Rem-Cru C-110 M," November 1, 1955.

Table I

EFFECT OF ALLOYING AGENTS

Element	*Purpose of Addition*
Aluminum	Improves scaling resistance and effects precipitation hardening in PH alloys.
Carbon	Provides elevated temperature strength and improved creep resistance; also hardness and strength in martensitic grades.
Chromium	Strongly improves corrosion resistance and elevated temperature scaling resistance.
Columbium, Tantalum and Titanium	Prevent intergranular corrosion in Cr-Ni grades.
Molybdenum	Improves corrosion resistance and increases elevated temperature strength.
Nickel	Improves workability, weldability, corrosion resistance, and elevated temperature strength.
Phosphorus, Sulfur, and Selenium	Improve machinability.

Table II

THREE MAIN CLASSES OF STAINLESS STEEL

Class	*AISI Types*	*Characteristics*
Austenitic	302, 304, 321, 316, 303, 310	Non-magnetic, tough, ductile, easily worked, excellent corrosion resistance, not hardenable by heat treatment.
Ferritic	430, 405, 446	Magnetic, good heat scaling resistance, not hardenable by heat treatment, very good corrosion resistance.
Martensitic	410, 420, 440, 416, 431, 403	Magnetic, hard, strong, hardenable by heat treatment, good corrosion resistance.

Table III

STANDARD HEAT TREATMENTS AND RESULTANT PROPERTIES

	TH 1050	RH 950	CH 900
Heat to:	1400 F	1750 F	Cold Reduced in mill
Held For:	90 min	10 min	to Condition C
Cool To:	60 F	—100 F	—
Hold For:	30 min	8 hrs	—
Heat To:	1050 F	950 F	900 F
Hold For:	90 min	60 min	60 min
	+ air cool	+ air cool	+ air cool

Table III (Contd.)

17-7 PH

Ultimate Tensile Strength psi			
typical	200,000	235,000	265,000
minimum[2]	180,000	210,000	240,000
0.2% Yield Strength psi			
typical	185,000	220,000	260,000
minimum[2]	150,000	190,000	230,000
Elongation, % in 2"			
typical	9_1	6_1	2
minimum[2]	6	4	1

PH 15—7 Mo

Ultimate Tensile Strength psi			
typical	210,000	240,000	265,000
minimum	190,000	225,000	—
0.2% Yield Strength psi			
typical	200,000	215,000	260,000
minimum	170,000	200,000	—
Elongation, % of 2"			
typical	7_3	6_3	2
minimum	5	4	—

1 — over .036" thick. Value is lower for thinner material.
2 — minimum values are guaranteed.
3 — over .020" thick. Value is lower for thinner material.

Table IV

EFFECT OF AGING TEMPERATURE ON 17-4 PH

	900 F - 1 hr	925 F - 4 hrs	1025 F - 4 hrs	1075 F - 4 hrs	1150 F - 4 hrs
Tensile Strength—Psi	200,000	190,000	170,000	165,000	145,000
0.2% Yield Strength—psi	178,000	175,000	165,000	150,000	125,000
Elongation—% in 2"	12	14	15	16	19
Reduction of Area—%	48	54	56	58	60
Izod Impact—Ft. lbs.	20	25	35	40	50

TODAY'S MOST IMPORTANT NEW PRIME MOVER

By J. R. Dunne,
G. E. C., U. S. A.

OVER 2000 years ago man successfully harnessed the energy in an expanding gas—in effect, discovering the principle of the gas turbine. Since 130 B. C., when Hero of Egypt built the first gas turbine—a small, hot-air driven toy carousel—men have continued to improve upon his idea.

During the 16th century the turbine principle was applied to turn a roasting spit. This was the first practical application of the gas turbine.

On November 30, 1791, shortly after the close of the American Revolution, the British Patent Office issued patent No. 1833 to John Barber. This patent described a gas-turbine power plant that included in elementary form all the principal components of the modern plant. Yet until about 1940, few engineers took this type of power plant seriously—the average person still thinks of it as a modern invention.

The principle of the turbine itself dates back to antiquity. And although it's apparent from Barber's patent that the principle of the gas-turbine power plant was understood from at least the beginning of the 19th century, neither steam nor gas turbines were built during most of that century. Instead, the reciprocating steam engine was developed early and remained for many years the dominant type of power Plant. Probably the high operating speeds required for large turbine outputs and high efficiencies were excessive for the materials and bearings of the day. Nor was theory, especially as it pertained to turbine nozzles, adequate to provide a good foundation for practical design.

Early in the 20th century, however, the steam turbine was perfected; and in a few years it had almost completely superseded the reciprocating steam engine. You might logically expect parallel development of the gas turbine. On the contrary, almost contemporaneously with the perfection of the steam turbine, development of the reciprocating internal combustion engine began. And many years passed before attention turned to the gas turbine.

General Electric became interested in the industrial possibilities of the gas turbine as a result of a doctorate thesis written by Sanford A. Moss in 1900. Dr. Moss later joined General Electric and was given facilities in Schenectady to continue his research and development work on turbosuperchargers and gas turbines.

Development of rotary compressors—both of the centrifugal, or radial-flow, and axial-flow types—dates from about the beginning of the present century.

Because of its greater ease of manufacture and correspondingly decreased cost for low pressure ratios, the centrifugal type progressed much more rapidly than axial-flow compressors. From 1910 onward a large number of centrifugal compressors were built for blast-furnace and other industrial applications. During the closing days of World War I, the centrifugal compressor was selected for the turbosupercharger—the immediate predecessor of the aircraft gas-turbine power plant. Meanwhile, although Sir Charles Algernon Parsons had built a few axial-flow compressors in the 1900 to 1910 period, for many years development of this type proceeded slowly.

Engineers' interest in the independent gas-turbine power plant didn't lag while the steam turbine and the reciprocating internal combustion engine were in process of development. Though a number of investigators were active in gas-turbine research previous to and just after 1900 and though their work constituted a necessary foundation for later development, no practical power plants were produced. Charles Lemale and Rene' Armengaud in France, Norman Davy in England, and Dr. Sanford A. Moss in the United States are representative of the workers in the field at that time. About the beginning of the century, Hans Holzwarth began a long career devoted almost exclusively to the constant-volume, or explosion, gas turbine. This type has met with far less favor than the constant-pressure type, although the compound aircraft engine operates on essentially the same cycle.

In 1918 the Army accepted the first General Electric turbosupercharger—a device utilizing a small turbine rotor to increase the normal air intake of an internal combustion engine, permitting greater power and efficiency at high altitude.

Several different ground power plants were built or begun during the 1930's. Among them were two of Holzwarth's design, manufactured by Brown Boveri Limited, the first of which operated successfully for short periods as early as 1933 and completed a nearly continuous run of 470 hours in September 1937. The August Thyssen Steel Works of Hamborn, Germany, then ordered a second unit of 5000-kw capacity, installed in 1940. Successful operation of the second unit, probably the first large industrial gas turbine in actual service, was reported but details aren't available.

Beginning about 1931, Brown Boveri developed a boiler, in reality a supercharged steam generator. In it, the hot products of combustion are forced around the water tubes at high pressure and high velocity to increase the rate of heat transmission. A gas turbine operated by the waste gases from the boiler furnishes the power for compression. Although not strictly an independent power plant, it provided a powerful stimulus to further development, especially of axial-flow compressors.

The Houdry cracking process for producing gasoline, in which a certain operation is carried out with gas at high pressure and temperature, furnished another stimulus for the gas expanded in a turbine to deliver sufficient shaft power to drive an electric generator as well as the necessary compressor. These turbines, first developed by Brown Boveri, have been manufactured in this country by Allis-Chalmers and operated for long periods at the Marcus Hook refinery of the Sun Oil Company.

Among the other gas turbines of the 1930's was a constant pressure unit of George Jendrassik's design built at Budapest, Hungary, in 1935, with assistance from the Hungarian government.

Also, a constant-pressure stand-by plant for a bombproof shelter was built by Brown Boveri for the city of Neuchatel, Switzerland, in 1936.

The Jendrassik unit, which included an axial-flow compressor and regenerator, developed about 100-hp. net output at 16,400 rpm. with a thermal efficiency of 21.2 percent. The Neuchatel unit of 4000-kw. capacity uses no cooling water and requires as an auxiliary only a small diesel-driven alternator to supply the starting motor in the event of a complete power failure. (Its efficiency is reported to be about 17 percent, since it has no regenerator.) In 1939, Brown Boveri also began designing a gas-turbine locomotive that from 1942 onward operated successfully for long periods on non-electrified railway lines of the Swiss Federal Railway.

During World War II, the General Electric turbosupercharger helped allied aircraft to fly higher, faster and farther than the enemy.

A turbosupercharger is similar to an independent gas-turbine power plant except for the absence of a combustion chamber. Production techniques were well developed for the turbosupercharger. (Shortly thereafter several hundred thousand turbosuperchargers were built to make possible the high-altitude flying of Flying Fortresses, Super-fortresses, Liberators, Lightnings, and Thunder-bolts in World War II.)

In September 1941, the Air Force asked General Electric to undertake development of the aircraft gas turbine in the United States and asked Bell Aircraft to design a suitable airplane. Within six months of the time work began, General Electric completed its first unit. And the first jet engine flight in the United States occurred at Rogers Dry Lake (formerly Muroc), California, in October 1942.

Yet the increase of scale involved in passing from turbosuperchargers to independent gas-turbine power plants necessitated not only new tools and other manufacturing facilities but also development of new metallurgical and manufacturing techniques. In general, operating stresses and gas temperatures required were no higher than for the turbosuperchargers. But obtaining the necessary strength in some of the parts with larger dimensions proved more difficult. It isn't surprising, therefore, that in the absence of an emergency the large financial outlays required weren't favored.

This background in basic turbine researeh and development enabled General Electric to successfully design and build the aircraft gas turbine for the Air Force. Convinced that the gas turbine could make an important contribution to the industrial growth of America, General Electric established the Gas Turbine Department.

Since 1948, when the first gas-turbine-electric locomotive went into operation, the General Electric gas turbine has found its place as a widely accepted prime mover in a diversity of industries. Through a dynamic program of research and development, new applications for this versatile prime mover are continually being found.

In February 1956 a milestone of industrial progress was revealed with the announcement that 100 General Electric gas turbines had accumulated over 1,000,000 hours of operation, or the equivalent of 114 machine years' operating experience.

General Electric gas turbines then, as now were being used to generate electric power to furnish power for natural gas pipeline pumping where they contribute to lower pumping costs, for railroad locomotives where their dependability is demonstrated daily by operating over some of the most rugged terrain in the country, and in the petrochemical industry where continuous 24-hour, 7-day a week compressor service is required.

INDIA'S FIRST 'BILLION RUPEE' FIRM

DISTINCTION OF TISCO

The Tata Iron and Steel Co., Ltd., has earned the distinction of being the first billion (one thousand million) rupee company in India.

In terms of physical magnitude, the accounts of the company for the year ended March 31, 1958, which were released on Friday, are unique. The balance-sheet total which stood at Rs. 98.28 crores in 1956–57 has recorded a steep rise of Rs. 50 crores to Rs. 148.72 crores. This is mainly attributable to the swift progress made during the year on the company's two million ton programme. The gross block, for instance, has risen from Rs. 54.78 crores to Rs. 105.03 crores and secured loans from Rs. 11 crores to nearly Rs. 50 crores.

In this context, it may be recalled that as early as in 1955 the Chairman of the Company, Mr. J. R. D. Tata, stated that "the gross block of the company, during the next four years or so, will probably rise to Rs. 140 crores or more and its borrowings to something like Rs. 50 crores." He then estimated that by the end of the expansion programme a sum not far from Rs. 200 crores would have been invested in the company. Since then, there have, however, been major changes in the cost structure and the scope of the modernisation and expansion programmes involving substantially higher capital outlays.

SERVOMEX MOTOR CONTROLLER TYPE No. 43

By F. & D. Brownlie,
Technical Journalists, London.

THE demands of modern industry for electrical instruments suitable for high speed production processes are bringing into being an increasing range of equipment which is characterised by a performance of an extreme precision to meet the most exacting requirements.

Prominent among the manufacturers of this type of instrument are Servomex Controls Ltd. whose high precision motor controller type MC 43. has recently been placed on the market. Being expressly designed for rapid reversal it can be switched from full speed forward to full speed reverse in as little as 1.4 seconds and is therefore eminently suitable for high speed production work.

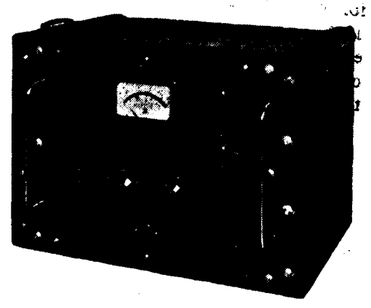
This instrument provides a mechanical drive in a convenient form, the speed range available being much greater than that obtainable with any other form of control. Once set, the speed is maintained at a constant figure to exceptionally fine limits.

It is suitable for operation with an input supply ranging from 200 to 250 volts, single phase, 50–60 cycles and provides a range of speeds from 0 to 6000 r.p.m. which can be smoothly varied in either direction. An electrical tachometer on the control panel enables the operator to determine the motor speed with a guaranteed absolute accuracy of plus and minus 1.5% of full scale.

The torque produced is a minimum of 21 ounce-inches at all speeds and does not diminish at the higher speeds. A feature of the instrument is that the application of full torque does not cause a speed change of more than 6 r. p. m. over the whole range of speeds. Further, at constant torque, mains variations of up to plus and minus 7% from the nominal voltage and frequency do not cause any drift of speed greater than 5 r. p. m.

The principle of operation is a D. C. motor with an approximate output of $\frac{1}{8}$ b. h. p. at 6,000 r. p. m. to which is coupled a D. C. tachometer generator specially designed to give an output voltage accurately proportional to speed. The generator voltage is compared with an electronically stabilised reference voltage, the discrepancy being amplified and used to increase or decrease the speed of the drive motor until the error is eliminated. The speed error can never exceed a few r. p. m. for more than a matter of milliseconds and the accuracy is so high that a suddenly applied load is normally adjusted in about one-twentieth of a second. No electrolytic capacitors are employed and a delay switch and relay prevent premature application of the H. T. before the valves are sufficiently warm.

If required, provision can be made for a remote speed controller. For certain applications requiring a range of different pre-set speeds, a switch which may be either manually or automatically operated can be provided to select these.



Instrument shown in rackmounting form.

The control unit is mounted on a standard 19 inches rack panel of 14 inches height. The depth is $15\frac{1}{2}$ inches and weight 88 lbs. A 12-way flexible cable 6 ft. in length connects it to the motor which is suitable for foot or flange mounting and has a $1'' \times \frac{1}{4}''$ shaft at each end. The weight of the motor is $7\frac{3}{4}$ lbs. All metal work is stove enamelled or cadmium plated. Wooden covers are available for bench use.

Further details may be obtained from the manufacturers at Crowborough Hill, Jarvis Brook, Sussex, England.

MAGNESIUM ALLOYS

By A. C. Bhattacharya, A.M.I. Prod. E.

THE light alloys are materials for which new fields, of use are always being found. The present 'Age of Alloys' has opened the eyes of many regarding the progress made in their use and acts as a pointer to the possibilities ahead.

Magnesium base alloys, by virtue of their lending themselves to easy manipulation, machinability and weldability are now essential in most industries particularly in aircraft industry. Adding ease of working to great lightness and strength they accelerate production right along the line.

The metal itself, which is a relatively soft silver-white metal and does not possess the strength required for structural uses; but when alloyed with certain other metals, a wide range of properties may be obtained, was discovered by the French Chemist Bussy in 1829, but it was not developed for alloys until nearly a century later. During the last war magnesium being 40% lighter than aluminium was a metal whose alloys had become vitally important to the R. A. F. re-armament programme, as well as to industry generally. Following the war great progress has been made in developing new ultra-light alloys based on magnesium possessing the increased mechanical properties demanded by the aircraft and aero engine industries.

PROPERTIES OF MAGNESIUM ALLOYS

(a) Lightness—The weight of magnesium alloys is about 0.065 lb. per cu. in., compared with 0.28 lb. per cu. in. for steel.

(b) Strength—The tensile strength of the alloys is up to 24 tons per square inch compared with 100 tons for the best steel. The strength weight ratio for the best steel is therefore 800,000 to 1 and that of the best magnesium alloy 827,000 to 1; so that weight for weight, the best magnesium alloy is stronger than the best steel. A magnesium alloy of comparatively lower strength, i. e. with a ultimate tensile strength of 13 tons per sq. in. is, weight for weight, more than twice as strong as the best mild steel. The compressive strength of the alloys when compared to cast iron is twice as good as the latter, the best ferrous compressive metal.

Besides the above, the magnesium alloy has high dimensional stability, excellent surface finish and good bearing properties. Machinability is very good as a result of which, all production jobs involving the use of such alloys start with assured advantages in time, power, equipment, man hours, floor space and tools.

Among the drawbacks affecting the magnesium alloys are: natural corrodibility, brittleness and hardness. To improve resistance to corrosion, magnesium alloys are given protective treatment. The best magnesium alloy is five times as brittle as an ordinary high-tensile steel. No magnesium alloy yet has a Brinell Hardness Factor of 100, whereas steels have from two to six times that value Magnesium and its alloys are very sensitive to rolling conditions.

ALLOYING METALS

The metals at present alloyed with magnesium are aluminium, Zinc, manganese, copper, silicon, cadmium, and, in cast alloys, tin and silver. Unintentional impurities generally present are tin, lead, copper, iron and silicon. When alloyed with Cadmium, the metal becomes soft and ductile as the addition of cadmium does not materially alter the ultimate strength. Aluminium increases the tensile strength of magnesium alloys up to about 6 per cent. Too much addition of aluminium is however harmful as it renders the metal brittle. Zinc increases the ductility. The addition of zinc and cadmium produces alloys of moderate strength coupled with high ductility while aluminium and zinc together are necessary for extruded magnesium alloys generally. Manganese improves the corrosion resistance, and copper the heat transference and electrical conductivity.

For extruding, magnesium-aluminium-cadmium alloys, a recent development, have been found suitable. For strength and good ductility, the latest magnesium-nickel-copper alloys have established themselves and are widely used.

HEAT TREATMENT

The heat treatment of magnesium wrought alloys consists of solution treatment at about 400°C. followed by air cooling or water or oil quenching; following this the material may be artificially aged at about 170°C., being then cooled in air.

Some alloys are only annealed, at about 270° C., for about four hours; and many have no heat treatment whatever.

The solution heat-treatment is performed in specially designed ovens at temperatures varying from 330 to 420 degrees centigrade depending upon the alloy. Alloys so treated are in the best condition for shock resistance. When high yield strength is required both heat treating and aging are required to be done.

GRAIN REFINEMENT OF CAST ALLOYS

The grain refinement because of its effect on tensile properties, hot-cracking, and heat-treatment is an important aspect to be considered in this connection. The refining may be done in several ways. These include:—(i) superheating (ii) inoculation (iii) agitation and (iv) the Elfinal process.

Superheating consists in raising the temperature of the melt to approximately 900 deg. C., and then rapidly cooling the melt from high temperature to the pouring temperature. It has been observed that this method of grain refinement has particular effect on alloys of magnesium and aluminium specially if manganese and/or iron are present in excess of their solubilities. Possibly the most widely accepted theory of this method of grain refinement is that elements or compounds are present in the molten alloy but are not effective nucleating agents at the lower temperature of the melt. They are, however taken into solution at the higher temperature and then re-precipitated on cooling thus providing many effective nuclei for crystallization and consequently a fine grain.

The method however suffers from the following drawbacks:—

(a) The possibility of slag inclusions in the casting resulting from the difficulty to control during pouring the heavy layer of flux that would be used to prevent burning.

(b) Iron absorption by the alloy from iron pots with consequent decrease in its resistance to corrosion.

(c) Loss of grain refinement obtained by superheating on remelting.

(d) Increased fuel consumption and labour cost, extra time and increased wear on melting pots.

Inoculation consists of adding nuclei to a melt and in the case of magnesium alloys containing aluminium, the inoculant used is carbon. The most widely practised method is to plunge a tablet of hexachlorethane, a volatile organic chloride, into the melt held at a temperature of 760 deg. C., when the chlorine is released for degassing and carbon absorbed by the melt.

Grain refinement has been achieved by agitating melts which have been held in the temperature range of 750 to 800 deg. C. The impossibility of agitating large melts is, however, a great drawback to the practical use of this method.

In Elfinal process, one per cent of ferric chloride is plunged beneath the surface of the melt at a temperature of 820 deg. C.

In many alloys of magnesium the formation of aluminium carbide is not possible and the same is not considered desirable as well. The initial discovery that a small addition of zireonium causes an intense grain refinement of magnesium, made by Professor Sauerwald of the I. G. Farbenindustrie, in 1938, came as a great relief in such cases. The refinement is due to the zirconium in solution in the melt precipitating during solidification to form nuclei upon which the alloy can crystallize.

Zirconium is best added to the alloy in the form of a salt because it is both economical and simpler to add it in this manner. The present practice is to place a fluoride salt of zirconium in the pot in the initial charge. When the melt reaches the approximate temperature required for pouring the casting, the residue of salts remaining on the bottom of the

(Continued on page 16)

PRODUCTION BORING

By H. J. Pearson

Deep-hole boring is now an established production process showing considerable economic advantages over traditional methods of working. During the development period over the last five years, it has been applied to shorter-length parts having a depth/diameter ratio as small as 8 : 1. In most instances it has shown a definite increase in production efficiency in the most favourable circumstances an increase in production of some 15 times that considered reasonable by traditional methods has been obtained. The introduction of the Berthiez machine which is described in this article shows the extend of the developments that have taken place in this very specialized sphere of machine-tool design

THE time that elapses between the introduction and the acceptance of a substantially new and improved method of machining depends upon a number of factors, which include prejudice (or the rapidity with which a true knowledge of the technique is acquired) as well as upon the purely technical aspects. This initial stage usually occupies some 3 to 5 years.

Deep-hole boring using the Beisner Technique has followed the usual pattern of development. Since 1951, when it was first applied as a production-engineering process - as distinct from a gun-boring operation - it has now arrived at the stage where the term has become synonymous with a specific method of working rather than a condition of the operation. During this period the most significant development has been the realization that the process can also be justified economically for the shorter-length type of workpiece which is normally considered well within the scope of a turret-lathe operation, that is, parts as short as 4–6 in. in length. In these circumstances and providing that the length/diam. ration is between (say) 8 : 1 and 15 : 1, penetration rates of 8–10 in./min. are by no means uncommon.

The economics of these low-ration operations are, however, dependent upon the quantities to be produced or footage of boring required during a specific period. Another factor to be considered when machining the short type of part is the need for loading and unloading a workpiece every 45–75 sec. Here, a cost analysis is necessary to determine the economics of single-pass high-speed boring in relation to traditional methods of working, where a second and sometimes third operation such as drilling and reaming, may be required.

Until recently deep-hole boring has been a relatively expensive process to apply because of the high cost of tooling by reason of an unpredictable tool-life. The cost/reliability factor has now been largely overcome by a better understanding of the operating conditions and the equipment required. However it is not possible to state, categorically, the increase in efficiency of working that is possible with this technique as it is subject to a number of variables peculiar to each specific application. What has been established is, that the Beisner system of boring and trepanning, where the coolant-oil is fed around the outside of the bar and returns through the centre of it carrying the swarf away from the cutting zone, shows an increase in production of between 10-15 times that possible by the traditional methods of working, while the cost of the operation for the same period of working rises by only 3–6 times.

Most of the developments in this field have taken place in the medium-diameter and medium-depth range of boring and it is interesting to record the introduction of a French built machine for operation in this category.

This machine, known as the Berthiez type 1560 is designed for pierce-boring operations between 13/16″ and 2″ diam. on parts between 6″ and 28 $\frac{6}{16}$ inches length. It has been developed from the series of gun-boring and rifle-boring machines. The first machine of this designation has been in continuous operation on the boring of stainless-steel billets since July 1956 and has replaced the battery of 10–12 turret lathes previously needed to maintain the same rate of production.

The general layout of it is seen in Fig. 1 there is a unit type bed 10 ft. in length, with a standard-pattern headstock and a separate feed-gearbox at the opposite end. The cutting-oil pressure-head and boring-bar carriage are traversed by independently-operated mechanisms from a stationary and pretensioned feed-screw in vertical alignment with the centreline of the axial-thrust of the boring-bar. For example the pressurehead is advanced and retracted in relation to the workpiece for clamping by a 3 h. p. flange-mounted motor projecting rearwards from the carriage. This unit includes a pressure-release mechanism which, when a predetermined pressure is reached disengages the drive-mechanism and hydraulically-operated heel-clamps are brought into action to clamp the pressure-head carriage to the bed.

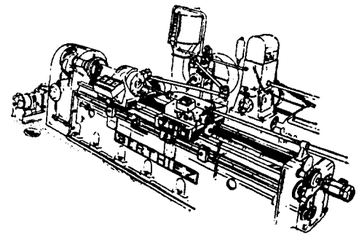


Fig. 1. — The Berthiez type 1560 machine designed for continuous operation on the medium diameter, medium length, part. It is fitted with a 50 h.p. main motor and has infinitely-variable spindle-speeds from 140 to 1,800 r. p. m. by means of a Ward-Leonard set. A pre-tensioned stationary feedscrew is used for movements of the pressure-head and boring-bar carriages. The feeds are also infinitely variable in two ranges between the limits of 0.0013 in. and 0.025 in./rev. by means of a variator drive from the main motor to the gearbox at the end of the bed which, in turn, drives a splined coupling-shaft. Rapid traverse of the boring-bar carriage is by means of the flanged-mounted motor seen extending beyond the gearbox casing. The pressure-head is advanced and retracted by an independent drive-motor which connects with a nut on the feedscrew.

The boring-head carriage is advanced and retracted by the feed-gearbox at the end of the bed. Cutting feeds are obtained through a two-stage spur-gear train-in conjunction with a variator control-unit in the head-stock casing—to obtain infinitely—variable feeds of from 0.0013–0.025 in./rev. The feed-mechanism includes a protective device for retracting the boring-bar in the event of tool-breakage or similar sudden increase in resistance to cutting over and above a preset value. It consists of a thrust-indicator mechanism which can be set to disengage at a definite loading.

All the controls required for a production operation are contained in a console-unit which is mounted at the front of the oil pressure-head carriage. On the console, and reading from left to right, the dials indicate spindle-speeds from 140—1,800 r. p. m. ammeter for main motor, and ammeter for coolant pumps. Below these indicators, the first two groups of push buttons are for starting and stopping the main motor and increasing and decreasing the spindle-speed. Change of speed is obtained by maintaining a steady pressure on the appropriate button until the speed required is

(Continued from page 15)

pot are stirred into the metal. The metal is then allowed to remain in the furnace at a holding temperature and during this period, any fluoride flux entangled in the melt is able to separate. This method of grain refinement is rapid easy and effective and mechanical properties obtained from metal treated with zirconium are very consistent.

APPLICATIONS

Magnesium alloy sheet which is produced by rolling direct from carefully cast slab, is now being used for the skins of aircraft fuselages, mainplanes, tailplanes and control surfaces. The best mechanical properties are obtained at right angles to the direction of rolling. Other applications include motor bodies, tea and table trays and even frying pans, furniture (mainly from welded tubes), refrigerators, radiators and oil sump. An oil sump which weighed 124 lbs., made in iron, weighed 50 lbs., in aluminium and 30 lbs. in magnesium alloy.

Magnesium alloys are available in the wrought form as extruded rods, bars, angles, special sections and tubes and as pressings and forgings. The high strength to weight ratio offers clear advantages to the designer; further more the ease with which the material can be manipulated and welded, coupled with its high machinability, enables intricate designs to be executed at reasonable cost.

Structures built from magnesium wrought alloys generally represent a combination of formed sheet and plate with extrutions of various types: castings, too, can sometimes be incorporated in such work, by virtue of the ease with which welds between the wrought and cast alloys can be made.

Where exceptional lightness combined with strength is of the utmost importance, the magnesium alloy finds a place. The excellent performance of the components, so far made from magnesium alloys, under exacting conditions, is outstanding proof of their value in modern engineering.

indicated on the dial. The third paid of buttons from the left are used for the direction of boring-bar traverse. Feeds in relation to spindle r. p. m. are obtained by means of the variator unit. The control for this unit is a setting-disc at the front of the headstock with two sets of calibrations, corresponding to the feed-ranges obtained by the use of two pairs of change-gears in the feed-box attached to the end of the bed. The last pair of buttons on the console, separated by a tumbler-switch, control the advance and retraction of the pressure-head carriage. The button on the left contains a signal-lamp, which is illuminated when the pressure-head carriage is in pressure-contact with the workpiece and the clamps have been applied. The tumbler-switch is used for controlling the direction of motor-rotation and therefore direction pressure-head traverse.

The trust-indicator for the boring-bar is mounted on top of the carriage. In effect, it is a pressure-guage where the trust is calibrated in units of 50 kg. (110.25 lb.) The maximum permissible thrust-setting for a specific operation is obtained by rotating a second sweep-hand on the indicator needle-staff to the required value (in a manner similar to that of setting the working tolerances on a dial-indicator gauge). When the actual thrust-load needle reaches this value, an electrical circuit is energized to disengage the feed. The extent of rapid traverse and feed traverse of the boring-head is controlled by the limit switches at the front of the machine. These switches are discussed in greater detail later on in this article. In passing however, it may be mentioned that the traverse-trips make use of a forward-movement stop so arranged that, if the boring operation is stopped before it is completed, it is possible to advance the boring-head at rapid traverse right up to the point where boring ceased, before the cutting-feed is again engaged.

PRODUCTION-BORING

The machine shown in the various illustrations is installed at the works of Comptoir Industries d'Etirage et Profilage de Metaux, at Persan-Beaumont, near paris. This company specializes in the production of turbine blades, engine-rings and the hot extrusion of steel sections. From the historical aspect, this company were the originators - in collaboration with Acieries Electriques d'Ugine—of the use of glass-fibre for the lubrication of hot-extrusion dies. Up to the present, the Berthiez machine has been used continuously for pierce-boring operations on various grades of stainless-steel billets.

In each instance, the principal requirement at Persan has been the production of a good surface-finish and close-tolerance on diameter. These requirements take precedence over straightness in the bore, which is controlled by extrusion after boring.

At this plant, the particular production difficulty has from the outset been the drilling operation, which has to be evaluated in terms of ft/day rather than a specific number of billets which in the case of an 18 in. part is finally extruded to a length of 315 in. In the past, the desired level of production has been maintained by subcontract-boring and by traditional methods, using turret-lathes. Even with the limited experience that the company has with the deep-hole boring technique, the following average daily production figures show the progress that has been made :—

8 hr. shift 106 billets 13.8" in length bored 1.339" diam = 122 ft/day.

8 hr. shift 82 billets 17.72" in length bored 1.339" diam = 118 ft/day.

These figures correspond to 13 parts per hour for the shorter component and 10 parts per hour for the longer work piece and this represents the demand, rather than the limits of the machining process. The billets are loaded by overhead hoist equipment on to protective wood blocks laid across the bed of the machine. The loading of a new billet and the removal of a machined part takes place while a workpiece is being bored. The layout of the deep-hole boring equipment is shown in Fig. 3. Here, the machine is somewhat dwarfed by a billet-loading fixture extending from

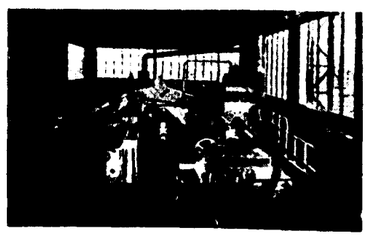


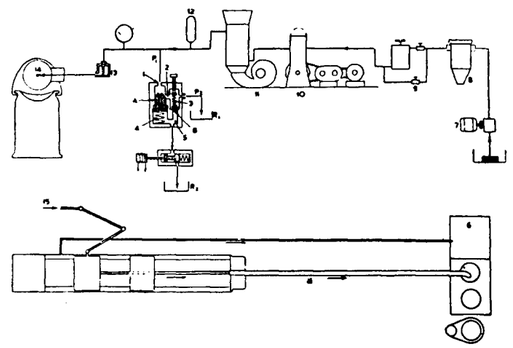
Fig. 3. — General view of the cutting-oil installation at Persan-Beaumont showing the reservoir in the foreground. A 50-h.p. motor and variator set is used for driving the main pump. Between 170-200 gal. of oil is in use : this quantity allows for continuous operation.

the back of the headstock and across the spindle. An elaborate coolant-system is used, and this incorporates two single-stage pumps with refrigeration equipment and a bleed-off circuit for the hydraulic clamps on the pressurehead carriage. The system is designed for continuous operation with the minimum amount of oil. Whether or not this extensive equipment is preferable to the use of a much larger quantity of oil is a point for conjecture and it offers, perhaps an object lesson in the consideration of coolant-supply.

Figure 4 shows a schematic arrangement of this circuit which is efficient in operation to the extent that the recirculated oil does not exceed a temperature of 82 deg. F. at the end of an 8 hr. Shift. Settled-out oil from the right of the reservoir in the foreground of Fig. 3 is drawn into the circuit by a 2 h. p. centrifugal-pump with a capacity of 66 gal./min. at 14½ lb. sq. in. pressure. As stainless-steel swarf cannot be separated out magnetically, the oil is passed through a mechanical filter and when necessary, a cloth-type filter. First-stage filtration is effected by a four-bank housing. This action causes the wiper arms between the filter discs to rotate and spill into a duct in the base of the filter any foreign matter that is lodged in the plates. Any excess oil that might be surrounding the particles is allowed to drain into a separate reservoir. The period between this manual cleaning depends, of course, upon the condition of the oil after it has settled-out in the main reservoir. After it leaves the Auto-klean filter, the oil can be passed directly into the high-pressure circuit or passed through a Sofrance cloth-filter for fine-article separation, depending upon the requirements of the operation. This filter has a flow-capacity equivalent to be first-stage pump but offers a severe restriction to flow if the oil is contaminated to any appreciable extent. After the coolant has passed through the filters, it is drawn into the high-pressure pump-circuit. This is also a somewhat complex installation and has a 50 h. p. drive-motor which drives a Texrope variator-unit, the output side of which is connected to a four-cylinder Worthington pump or supplying pressure-oil into the main circuit. The variator speed-control unit can be adjusted by a handwheel to give any output speed between the ratio of 1 : 3 by the displacement of two cones. The Worthington piston-type pump to which it is coupled has a minimum delivery of 18 gal./min. at 711 lb. sq. in. pressure.

After the oil has been raised to about the required pressure and to the appropriate rate of delivery, it is passed through an air-cooling refrigerator to reduce the heat-gain build-up acquired during machining and circulation through the two pumps. This equipment is seen on the right of the machine in Fig. 3. The heat-exchange is effected by a 6 h. p. fan which draws air into the lower part of the refrigerator where it passes around helically-wound tubes carrying the oil. Heat extracted from the oil is evacuated through ducting that passes through the wall. In order to minimize the undesirable effects of pulsation that must inevitably occur in a pressure-line from a piston pump the output side of the pressure-oil pipe is in circuit with a part air, part hydraulic accumulator. In essentials, this is a bottle of compressed-air, the pressure of which is balanced with the line pressure of the cutting-oil so that it absorbs the slight variation in pressure caused by the pulsation effect of the pistons.

A pressure-regulation and solenoid-controlled bypass circuit is shown on the output side of the accumulator



1. Inlet-port 2. Transfer-port 3. Outlet-port
4. Transfer-port 5. Discharge-port 6. Reservoir
7. Ist-stage pump 8. Mechanical filter 9. Cloth filter
10. Main pump equipment 11. Air cooler 12. Air-accumulator
13. Non-return valve 14. Pressure-head 15. Compass-joints
16. Return-circuit

Fig. 4. — Schematic arrangement of the coolant-circuit and the solenoid-controlled bypass and pressure-relief valves. The coolant is drawn into the circuit by a low-pressure pump, through the filters, and then to the 50 h. p. main pump set. The pumps are in continuous operation throughout a work-cycle while the coolant is circulated or bypassed through the dump-valves according to requirements.

in the schematic diagram. The pressure-regulation valve also functions as a dump-valve and this, when necessary, operates in conjunction with a solenoid operated valve to bypass the entire oil-flow to a

(Continued on page 20)

200-TON GOLIATH CRANE AT BRADWELL

By A Technical Correspondent

In an article dealing with constructional progress at the nuclear power station being built at Bradwell for the Central Electricity Generating Board by the Nuclear Power Plant Company, which appeared in our issue of January 17 last, brief mention was made of the Goliath crane being installed for handling the very heavy boiler and reactor structures. This crane, which has now been completed and successfully undergone its acceptance trials, can be seen lifting a 200-ton block in the illustration on page 22. It is designed to raise loads up to 200 tons on its main hook and 30 tons on an auxiliary hoist, and has a clear height of 140 ft. below the crab girder.

A GOLIATH crane, which has been installed at the site of the nuclear power station being built by the Nuclear Power Plant Company, Ltd., at Bradwell-on-Sea, Essex, is believed to be the largest equipment of its kind yet made. This crane was designed and built by Clyde Crane and Booth, Ltd., of Rodley, Leeds, and its associate company, Clarke Chapman and Co., Ltd., of Gateshead-on-Tyne, the sub-contractor for the steelwork being the Tees Side Bridge and Engineering Works, Ltd., of Middlesbrough. It is to be used for the lifting and placing of the very heavy boiler and reactor equipment, and its design and operation are such that it will permit civil engineering work on the reactor buildings to proceed uninterrupted whilst the heavy equipment is being handled. An impression of the duties the crane will be needed for is given when it is pointed out that in each of the reactor buildings there will be six 19 ft. diameter, 87 ft. high boilers, and a spherical steel pressure vessel 67 ft. diameter. These boiler shells, each weighing nearly 200 tons, will be floated by sea to the site from the factory of Head Wrightson and Co., Ltd., at Thornaby-on-Tees. The reactor pressure vessel, which weighs some 1100 tons, will be fabricated on site and handled in sections by the crane.

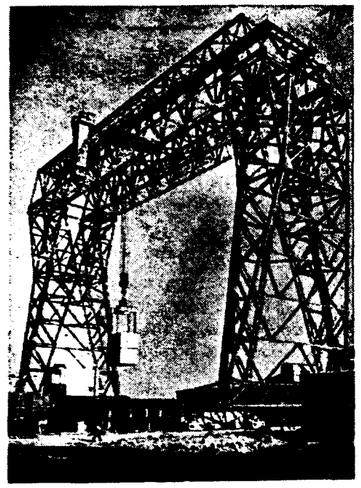
(Continued from page 19)

return-circuit pipe without circulating through the machine. Oil is bypassed at the end of a machining operation and during an emergency retraction of the boring-bar. That is, the pump-circuit is in continuous operation and the oil-flow is directed as required during the course of the machining cycle.

PRESSURE REGULATION

Returning to the pressure-regulator schematic diagram, (page 19) that the solenoid-operated valve is closed. Pressure in the main circuit opens the non-return valve and goes to the pressure-head, whence it is circulated through the boring-bar and finally returns to the reservoir. The line pressure in P causes a scalloped section conic-form piston A to retract and a small quantity of oil is passed from I to R, through ports 2 and 3. At the same time a bleed-pressure passes through a small hole in piston A into ports 4 and 5. This means that non-return valve plunger B is, from port 5, under pressure of P_1 and from port 3 under pressure of P_2 and the tension of the spring.

Pressure-regulation in the main circuit—within certain limits is obtained as follows: If the pressure P_2 and the tension of the spring are together less than P_1 (by adjusting non-return valve spring V) the pressure decreases in ports 4 and 5 and piston A moves to the left and so causes pressure in P_1 to decrease. When the solenoid controlled valve is opened, the pressure is immediately decreased in ports 4 and 5—the bleed-hole in piston A is very small so delivery is infinitesimal - and the piston A moves to the left and in so doing uncovers port 2. The non-return valves close and the entire delivery of the pump is bypassed to R_1, through ports 1, 2 and 3. Continuing in the main circuit, the pressure-oil is conducted through compass-joints in the slinging arms to the pressure-head, and returns through the centre of the boring-bar and the telescopic-tube extension to the main reservoir. After it has circulated through the boring-bar in the course of a machining operation, the oil is conducted into a basket-container in the reservoirs the first stage of filtration. As a basket becomes filled with swarf it is removed and placed in a centrifuge for extracting the oil remaining on the chips. Between 170–200 gals. of oil is in use relatively a very small quantity indeed - but it has been found sufficient when used in conjunction with the filters and refrigeration equipment. A certain amount of undesirable aeration must necessarily take place as the oil is recirculated every 10-15 minutes but the effects of this disturbance have not had any severe effect upon ultimate tool life when compared with other examples of deep-hole boring application.



200-Ton Goliath Crane at Bradwell.

The general design of the crane can be seen in the drawing we reproduce opposite. It is of overhead girder construction supported at each end by a leg, each leg being mounted on eight four-wheeled bogies. The crane is designed for a horizontal wind load of 5 lb. per square foot under the worst working conditions. With a centre distance of 178 ft. between the bogie rails and a clearance of 167 ft. between the legs, the crane completely straddles the reactor buildings, which are being built between the 1200 ft. length of standard gauge bogie tracks. The tracks on which the crane runs are carried on deep reinforced concrete continuous beams, which, in turn, are supported on closely pitched concrete piles. With this length of track the crane will be able to lift the ring segments of the pressure vessels from a site welding station towards one end of the site and deposit them in the reactors at the other end of the site. It will also take the complete boiler shells from a reception centre and place them in position, as well as carrying out other heavy equipment installation work within its operating area.

Leading Particulars of Goliath Crane

Main hoist :

Maximum load	200 tons
Hoisting speed	4 ft. 9 in. per minute
Drive	Two 50 h. p. motors

Auxiliary hoist :

Maximum load	30 tons
Hoisting speed	33 ft. per minute
Drive	Two 50 h. p. motors

Travelling :

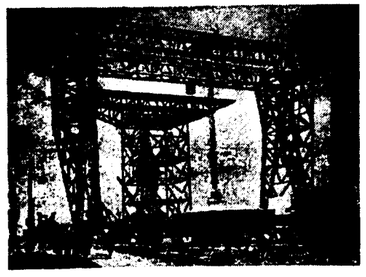
Track	1200 ft. long
Drive	Eight 20 h. p. motors
Speed (with 200-ton load)	50 ft. per minute
Track centres	178 ft.
Overall height of crane	177 ft.
Overall width of crane	226 ft.
Weight of crane structure	800 tons
Power supply (460 V d. c.)	200 kW diesel generator

The crane has a crab of conventional design which is mounted on rails along a pair of girders. As can be seen in the drawing, each of these main girder assemblies incorporates a complementary outrigger girder which imparts the required degree of lateral stiffness. These crab girders are supported at each end through legs of similar construction and the main vertical loads are taken through pin joints. One of the legs is anchored to the crab girder whilst the outer end of the other leg is left free with only a pin joint at the inner panel point. In effect, this arrangement makes the second leg a pendulum leg which, if required, can be rigidly coupled into the assembly. At its base each leg is pin jointed to the top equaliser beams of the bogies. Each top equaliser beam, of welded construction, transmits the load to two other equaliser beams which are coupled to the pairs of bogies through universal connections. By this arrangement the load is distributed over all the axles in each of the four bogies. The wheels and axles of the bogies are of standard railway construction and the axles run in phosphor bronze bushed bearings.

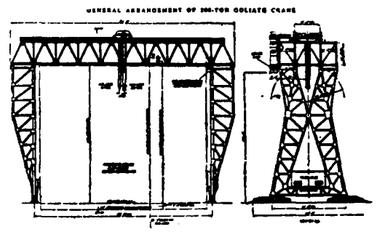
The front and rear axle in each bogie are driven through reduction and spur gearing by a 20 h. p. motor. Drive from each of the outermost axles is transmitted through side coupling rods to the mating axle on the same outer bogie. Thus, each eight-axle bogie has four driven axles. The eight 20 h. p. motors used for traction purposes give the crane a speed of up to 50 ft. per minute when carrying a load of 200 tons. Eight solenoid brakes are fitted to the travelling motion to hold the crane when at rest, normal braking being obtained by plugging through the control gear. In addition, storm clamps are provided to give further safety anchorage for the crane in gale conditions.

In order to keep the driver informed of the alignment of the two sets of bogies on the two sets of track an indicator synchronised by a " Selsyn " control is provided in the cab. In the event of " skewing " of the legs provision is made for realignment by braking the bogies on one leg and separately driving those of the other leg. We are informed that up to the present there has been no need for realignment as the design of the drive, coupled with the rigidity of the structure, is such that the maximum skew experienced so far has been little more than 2 in.

The crab assembly of the crane is fitted with conventional spur hoist gearing with the shafts running in ball and roller bearings. Barrels of steel tube construction are machine grooved and are arranged to coil the rope without overlapping; overwinding and over-lowering switches are provided for both the main and the auxiliary hoists. The main hoist and the auxiliary hoist are each driven by two 50 h. p. motors, the main hoist being capable of raising 200 tons at 4 ft. 9 in. per minute and the auxiliary hoist 30 tons at 33 ft. per minute. The crab is traversed across the working area by two 20 h. p. motors at speeds of up to 50 ft. per minute when handling a 200-ton load. Each hoist is fitted with automatic solenoid braking and the speed of lowering is also controlled electrically. When power is off movement of the crab is prevented by two solenoid brakes, and during operation normal braking is by plugging through the controllers. Current is supplied to the crab through a pick-up gear situated on one side of the main assembly and making contact with bare cables carried on struts on one of the outrigger girders.



Goliath crane with its erecting platform at the rear. A load of 200 tons is suspended from the main hoist.



The driver's cab is supported from an extension on one side of the crab and is positioned below the level of the top girder assembly. From this cab the driver has a clear unobstructed view of the load, which is always immediately below and in front of him, and the whole of the working area. With the control gear fitted each motion is independently operated by means of a master reversing controller which operates magnetic contactor gear. The speed of lowering on each hoist is governed by potentiometer dynamic braking and the rating of the resistances is such that a full load can be lowered the full length of travel of the hook once per hour. All of the electrical control gear is carried on the crab structure and is readily accessible for inspection or maintenance purposes. We are informed that when raising the maximum load of 200 tons the deflection of the crab girders is of the order of $\frac{3}{4}$ in. at the centre.

When designing the crane it was considered desirable to make it completely independent of main power supplies, which would have involved the use of long trailing cables. Power is therefore supplied by a diesel generator set built in an enclosure on one of the crane legs. The Crossley 200 kW diesel generator set used supplies current at 460 V d. c. for all the crane motions.

The method of assembling the main crane structure is of interest in that it is built up of shop-assembled riveted mild steel sections. These units were assembled together on site with high-tensile bolts using torque wrenches to give a predetermined and controlled loading on the nuts. With this method of assembly there has been obtained a working structure which can readily be dismantled and re-erected for use on other sites. It is stated that the crane itself took some fourteen months to assemble, and for its erection the large working platform to be seen in the background of one of our illustrations was used in conjunction with the jib crane in the rear. This Platform is now to be dismantled, whilst the jib crane, which runs on transverse rails across the main

Goliath crane tracks, will continue in service as it can be run clear of the main crane area when necessary. It is estimated that the crane can, when finished with, be dismantled in under six months without interfering in any way with the normal working of the station. Its availability during the building of the station is thought to have made possible a reduction of some six months in the overall construction time which would have been required. Furthermore, had conventional lifting equipment been used wider spacing would have been required between the main structures in the power plant.

HEAVY-DUTY COMPACTOR

A COMPACTING machine known as the "Vibro-Tamper" is now being imported into this country from the United States by Roadways Equipment (1938), Ltd., 232-242, Vauxhall Bridge Road, London, S. W. 1. The machine consists of a welded frame mounted on crawler tracks and carrying at the front six vibrating shoes. The shoes are attached to the frame by articulated links. Each shoe is 240 square inches in area and has a double vibrator unit driven from the main engine through V-belts, the vibration having a frequency of 2000 to 2200 r. p. m., with an amplitude of approximately ¼ in. The crawler tracks are driven from the 75 h. p. engine via hydraulic pump and motor; speeds range between 14 ft. a minute and 1¾ m. p. h. The compacting width is 12 ft. 6 in. with six shoes, 13 ft. 2 in. with extensions, or 8 ft. 6 in. with two shoes removed.

SIX FIRMS TO MAKE SUGAR PLANTS HERE

Six firms had been licensed for manufacturing sugar plants in collaboration with foreign firms from Germany, Czechoslovakia, France, Britain and Poland, the Minister for Industry told the Lok Sabha in answer to a question. There were eight other firms manufacturing parts of sugar mill machinery.

The Minister told another questioner that five firms had been registered for the manufacture of cement machinery and parts thereof.

EXPORTS: The exports of electric fans, and bulbs, sewing machines, and diesel engines and pumps during 1957–58 are more than in the previous year.. The government is reviewing the present policy of not allowing the export of skins of crocodiles and lizards.. The government is examining the feasibility of improving credit facilities through banks for export promotion.

An A. E. I. Company

New 18,400-kW Germanium Rectifier Equipment

From Our Special Correspondent

BTH TAKES ANOTHER STRIDE FORWARD

WITH the installation of a germanium power rectifier rated at 18,400 kW, 80,000 amps., 230 volts at the Ellesmere Port plant of the Associated Ethyl Co., Ltd., The British Thomson-Houston Co., Ltd., makes another advance in the field of semi-conductor power rectification. When the contract was placed, the equipment was the largest of its kind on order in the world. The rectifiers will supply D. C. power to two electrolytic cell lines for the production of chlorine, and will comprise two equipments each of four units, each unit being complete with its own transformer and associated switchgear.

The rectifiers are connected in a 3-phase bridge circuit with phase-shift transformers to give 48-phase overall operation. The output of each unit is controlled by means of an auto-connected regulating transformer equipped with 17-position on-load tap-changing gear and a trimming regulator to give fine control between tappings. The induction-type trimmer is excited from a tertiary winding of the regulating transformer and feeds back into a series boost transformer connected between the regulating and rectifier transformer primary winding. The regulating, series booster, and rectifier transformers are combined in one unit. The induction regulators are driven by selsyn receivers controlled from one master selsyn transmitter for each cell line. D. C. current transformers are provided to measure the D. C. output from each unit for metering and constant current control. The summated metering signal is compared with a pre-set reference voltage, and the error signal sent through an electronic amplifier to the amplidyne controlling the master selsyn transmitter. When the induction regulators reach the end of their travel, a transformer tap change is initiated and all four units are re-synchronised to ensure that correct load sharing is maintained.

The rectifier unit is divided into three cubicles, each cubicle holding six trays of germanium cells which are connected in a series parallel arrangement.

Both equipments are controlled from desks situated in a central control room, which also houses the metering, incoming and alarm panels.

The loss in the rectifier cell is very small and almost all this loss occurs during forward conduction and corresponds to a voltage drop of 0.5 volts per cell, thus giving a very high efficiency. The overall efficiency of the rectifier, main and regulating transformers, trimmers and phase shifters at normal load exceeds 96.0% and this high efficiency, together with the compactness of the equipment, gives ample justification for the installation of germanium rectifier equipment.

BTH TURBO-ALTERNATORS AND POWER TRANSFORMERS INSTALLED

The four turbo-alternators (three installed, one in course of erection) supplied by British Thomson-Houston for this station, are each rated 60 MW, 75 MVA, 0.8 power factor. The turbines are of the 2-cylinder, combined impulse reaction type, with double flow L. P. cylinders exhausting to twin condensers. They are designed for steam supplied at a normal pressure of 1500 p. s. i. g., temperature 1050°F., steam being bled from six points for feed heating to a final temperature of 400° F at the maximum load of 60 MW.

These machines have reversed HP cylinders with the steam inlet adjacent to the L. P. cylinder. Two steam chests are used, one cast integral into the top half and one into the bottom half HP casings and these are connected by two transfer pipes. The two emergency and stop valves are connected to the upper steam chest. Double casing construction is employed in the HP cylinder, the inner casing being of austenitic steel; steam is led into the inner casing through slip joints to allow for differential expansion. This construction limits the thermal stresses and distortion on the outer casings and a radiation shield is provided between the two casings to help in achieving this.

The exhaust casings are of welded steel construction. Both low vacuum and low boiler pressure suppression

gear are fitted. The governor and main oil pump are housed in the governor end pedestal and are driven by a hollow quill shaft which ensures accurate meshing of the worm and spur gear train regardless of alignment changes relative to the rotor. The gland sealing system is fully automatic. Electronic supervisory gear is fitted for indicating and recording eccentricity and differential expansion in the H. P. cylinders.

The alternators are hydrogen cooled and operate at a pressure of 0.5 p. s. i. g. They are wound for 11,800 volts, 50 cycles, 3-phase and are complete with direct-coupled double-unit exciter consisting of main and pilot exciter. The exciters are air cooled and take their air through viscous type filters in the foundation block.

The stator frame is a rigid gas-tight structure of welded steel and is designed to withstand the maximum pressure developed when the most explosive mixture of air and hydrogen is ignited inside it. The bearings and shaft seals are carried in the end shields.

The hydrogen coolers are mounted vertically in the stator frame and are cooled by distilled water which is, in turn, cooled by cooling water in two external coolers. Constant indication of hydrogen purity is provided by intrinsically safe instruments mounted on hydrogen panels. The pressure of hydrogen in the alternator is maintained automatically and an alarm sounds if the pressure falls below a preset value.

The shaft seals are fed with oil at all times while the machine is filled with hydrogen and this oil is vacuum treated to remove any absorbed hydrogen and air.

BTH has also supplied four 72-MVA, 11.8/141.6-kV generator-transformers for direct connection to the turbo-alternators and stepping up to the 132-kV grid; and two 10-MVA, 132/3.3-kV station transformers for providing a 3.3 kV supply to the station from the 132-kV grid.

The generator-transformers are forced oil water-cooled, having two Serck coolers on each unit. Terminal arrangements consist, on the H. V. side, of oil-filled chambers for the reception of Pirelli 132-kV cable; and the L. V. side has cable boxes.

The station transformers are naturally cooled. Terminals are of the same type as fitted to the generator-transformers.

All the transformers are fitted with on-load tap changers, remote controlled from the main control room. The transformers are suitable for outdoor service, being located in cells on the outside of the Turbine House wall.

The total weight of each generator-transformer in service is approximately 132 tons, transport weight 108 tons. The station transformers weigh approximately 69 tons and 51 tons respectively.

OUTPUT OF SEWING MACHINES

INCREASE REGISTERED

An increase of 25 per cent. was registered in the production of sewing machines in 1957 as compared with the previous year.

The number of sewing machines, manufactured in 1957, was about 1.67 lakhs as against 1.3 lakhs in 1956. In the first four months of this year the number of sewing machines produced was 65,000.

There are 35 manufacturers of sewing machines in the small-scale sector, besides seven firms in the large-scale sector.

Special steps are being taken by the Government to increase the output, particularly in the small scale sector.

*** *** ***

RAYON FABRICS EXPORT UP

In sharp contrast to declining exports of cotton textiles the export trade in rayon fabrics has continued to be brisk with shipments from the country revealing a progressive improvement. The value of overall exports during July has registered a more than 100 per cent improvement over the previous month at Rs. 72.01 lakhs. In June, exports were valued at only Rs. 34.81 lakhs.

The extent to which exports have improved in recent months may be appreciated from the fact that the value of exports in May and April was as small as Rs. 19.94 lakhs and Rs. 13.99 lakhs respectively. The total exports during the first quarter of the current year barely amounted to Rs. 16.35 lakhs. The performance during the last month has exceeded exports during the whole of 1957 and 1956 estimated at Rs. 51.22 lakhs and Rs. 60.56 lakhs.

IRON AND STEEL CLAD METALS

A New Group of Engineering Materials

By John Woodward
Manager of Marketing, General Plate Division,
Metals & Controls Corporation, Attleboro, Massachusetts

Over 400 clad metal combinations unite desirable engineering properties many of which are not available in single metals.

IT is now possible to molecularly bond both ferrous and non-ferrous base metals without brazing alloys or other intermediate agents to practically any malleable metal. These clad metals provide a new group of engineering materials, combining desirable engineering properties many of which are not available in single metals. Clad ferrous metals can be used to:

- Conserve critical alloys
- Lower manufacturing cost
- Increase overall strength
- Facilitate welding

Clad metals consist of two or more single metals inseparably bonded—usually under heat and pressure - to provide a material with each layer of uniform thickness. Perhaps one of the most useful of clad metal groups is the ferrous clad materials. Some of the ferrous clad metals commercially available today include:

Aluminum clad low carbon steel
Aluminum - low carbon steel - nickel
Nickel - low carbon steel - nickel
Gilding metal clad steel
Stainless clad copper
Stainless clad low carbon steel
Aluminum bearing alloy clad steel
Copper clad hardenable carbon steel
Other clad steel materials
Brazing alloys clad on stainless

ALUMINUM CLAD LOW CARBON STEEL

Aluminum clad steel, combining the surface characteristics of aluminum with the physical and mechanical properties of steel, frequently replaces other materials because of its proven heat-reflective and heat-resistant properties, and its ability to resist corrosion at elevated temperatures.

Heat exchanger tubes, liners and component parts for space heaters, water heaters, ranges, aircraft fire walls and toaster inner parts are a few typical applications. This material is well suited for applications requiring an aluminum surface to resist atmospheric corrosion and a steel backing to provide sufficient strength to allow substantial reduction in the guage of material required.

Aluminum clad low carbon steel strips are also used to replace pure nickel in many electron tubes. This material has proven comparable to pure nickel for many electron tube parts and has also reduced cost. It is more economical than nickel and its lower density gives over 20 per cent more parts per pound. Further cost reduction is obtained by eliminating the carbonizing operation required on some nickel parts. This clad material is supplied with a matte finish that provides maximum radiation properties after parts are "blackened" by firing. The radiation coefficient of the blackened material is about 85 per cent of a black body.

ALUMINUM—LOW CARBON STEEL—NICKEL

For some electronic tube parts the requirements call for a thin nickel layer on one side of the material. This material is a low carbon steel with a 10 per cent cladding of aluminum on one side and 10 per cent nickel on the other. Another electronic application is a small can, such as those used to enclose transistors and other parts in electronic devices. The aluminum layer provides a corrosion-resistant surface; the nickel, a surface suitable for soft soldering.

NICKEL - LOW CARBON STEEL - NICKEL

Another ferrous base metal combination has a thin nickel layer on both side. Primary uses for this material are found in the radio industry for tube parts, and by transistor manufacturers for nickel tabs.

GILDING METAL CLAD STEEL

Clad steel bullet jackets have replaced solid gilding metal (90 per cent copper - 10 per cent zinc alloy) and solid cupro-nickel (80 per cent copper - 20 per cent nickel alloy) jackets making available large tonnages of copper, zinc, and critical nickel for other purposes. For this application, gilding metal is clad to both sides of a steel core. Several steel companies have produced this clad metal for small arms ammunitions. Present clad ingots of 2,000—3,000 pounds permit high yield of usable material in fabrication. Processes for separating the steel and copper alloy clading permit salvage of steel and copper from the scrap.

STAINLESS CLAD COPPER

Stainless clad copper combines the high thermal conductivity of copper with the high temperature and corrosion resistance of stainless. The thermal conductivity of solid stainless is one of the poorest of all constructional metals, although the high temperature and corrosion-resistance properties are good. Stainless clad copper possesses a much higher thermal conductivity than solid stainless and eliminates the formation of hot spots at the point of heat concentration. Tests have shown that a 25/50/25 thickness ratio of double-clad stainless on copper provides an apparent lateral conductivity higher than solid copper. This point is explained by the fact that the stainless cladding is a partial heat insulator. The heat, therefore, is unable to dissipate as rapidly as it does with solid copper. Cooking utensils, cooling plates, fins for space heaters, and heat exchanger devices of various types are typical applications where stainless clad copper is desirable for uniform heat transfer. In other applications such as jet engine or gas turbine components, exhaust manifolds, and similar parts, the copper core is desired to increase lateral heat flow and prevent hot spot formations which might cause cracking or buckling.

STAINLESS CLAD LOW CARBON STEEL

Stainless clad low carbon steel is a low cost combination and is used in applications requiring the corrosion resistance of stainless steel. In cook ware, for example, the iron core is better for heat transfer than solid stainless, and less expensive.

ALUMINUM BEARING ALLOY CLAD STEEL

There are some bearing applications in which an aluminum bearing alloy is desirable but its low strength has made it unsatisfactory. Automotive bearing applications, as thrust washers, bushings, split bushings and other bearing parts are one such group. A new clad metal consisting of aluminum bearing alloy clad to a steel backing metal provides the required strength and fatigue resistance and yet maintains the aluminum alloy properties on the bearing surface.

COPPER CLAD HARDENABLE CARBON STEEL

Copper clad to one or both sides of hardenable carbon steel is one of the latest composite metals put into production for spring applications. This material compares to beryllium copper in many respects, but with somewhat lower fatigue resistance. Its primary advantage is lower cost.

The electrical conductivity of copper clad hardenable steel depends principally on the thickness of the copper-cladding. Ratios of thickness for the copper double clad on hardenable steel can be produced to offer higher electrical conductivity than beryllium copper when the same overall thickness of materials are compared. Also, the stiffness is higher for copper-clad hardenable steel than for beryllium copper. Typical applications are fuse clips, thin blade or spiral type springs, and clips used for electrical connectors not subjected to frequent arcing. In other applications, such as pen and pencil clips, the thin layer of copper provides a good surface for decorative electroplated finishes. In these instances, the thickness of the copper cladding layer need only be as thick as five per cent of the overall thickness of the material.

OTHER CLAD METAL MATERIALS

Zirconium, titanium, tantalum, and other similar rare metals are characterized by excellent corrosion-resistance, a high melting point, light-weight, and other properties which make them preferred for specific applications. Their use has been limited, however, because of their high cost and the difficulty of joining them. Some precious metals clad to steel are still in the development stage. Titanium clad steel, for example, has only been fabricated in small experimental amounts. A composite metal, consisting of the rare metal bonded to a common base metal,

provides a material that preserves the surface qualities of the rare metal, lowers the overall material cost, and simplifies the joining problem.

Platinum, gold, silver and their alloys clad to less expensive and stronger base metals have been used by the art and jewelry industries for many years. These materials are finding increasing use in industry for crucibles, electrical contact applications and similar uses.

Today a large percentage of electrical contacts are fabricated from composite materials. Considerable savings in cost through precious metal conservation are obtained; the steel, and other backing materials also provide desirable properties. For instance, a button type contact with a steel or Monel backing facilitates projection welding of the contact to its supporting member.

In many other engineering applications requiring the use of precious metals, it is desirable to keep the precious metal content to a minimum and composite metals are consequently required.

While optimum cost may be the principal goal in the selection of a specific thickness ratio of precious metal to base metal, in many cases the backing material provides functional properties such as spring characteristics, rigidity and magnetism.

CLADDING FOR BRAZING

Finally, mention should be made of brazing alloys clad to ferrous base metals. Cladding of this material is a rather unique development of interest to production men. The separate handling of small pieces of brazing alloy is eliminated by fabricating parts from materials that have the brazing alloy pre-clad to the brazing surface. The brazing alloy and parent metal are bonded and rolled similar to the manufacture of other clad materials. The advantages of having the brazing alloy supplied as an integral part of the material is quite obvious—primarily it eliminates the separate fabrication of small pieces of brazing alloy, and the handling of these pieces during the brazing operation, and decreases the number of surfaces to be joined.

CLAD METALS ARE DESIGNED FOR SPECIAL APPLICATIONS

Many of the ferrous metal combinations discussed here have provided to meet special applications and many other ferrous metal combinations will be manufactured and marketed as engineering demands them. A few additional combinations have been produced. One of these is nickel clad iron for devices based on the magno strictive principle. In applications of this material, a clad metal sensitive to the magnetic field is substituted for heat sensitivity.

With all the metal combinations now possible in sheet, tubing and wire, it would be worthwhile to study present metal applications as well as future product designs to determine if a clad metal will reduce material or fabricating cost, provide a combination of engineering properties otherwise unavailable, conserve a critical metal, and/or improve the characteristics of the product.

CLAD METALS CONSERVE EXPENSIVE ALLOYS

These metals can also increase overall strength and speed-up welding

Both ferrous and non-ferrous base metals can now be molecularly bonded (without brazing alloys or other intermediate agents) to practically any malleable metal.

These clad metals provide a new group of engineering materials, combining desirable engineering properties, many of which are not available in single metals. Clad ferrous metals can be used to conserve critical alloys; lower manufacturing cost; increase overall strength; and facilitate welding.

Clad metals consist of two (or more) single metals inseparably bonded (usually under heat and pressure) to provide a material with each layer of uniform thickness. Perhaps one of the most useful clad metal groups is the ferrous clad materials. Some of the ferrous clad metals commercially available today include:— Aluminum clad low carbon steel; aluminum—low carbon steel—nickel; nickel—low carbon steel—nickel; gilding metal clad steel; stainless clad copper; stainless clad low carbon steel; aluminum bearing alloy clad steel; copper clad hardenable carbon steel; other clad steel materials; brazing alloys clad on stainless.

Aluminum clad low carbon steel. Combines the surface characteristics of aluminum with the physical and mechanical properties of steel and frequently replaces other materials because of its well proved heat-reflective and heat-resistant properties, and its ability to resist corrosion at elevated temperatures. Heat exchanger tubes, liners and component parts for space heaters, water heaters, ranges, aircraft firewalls and toaster inner parts are a few typical applications. The material is well suited for applications requiring an aluminum surface to resist atmospheric corrosion and a steel backing to provide sufficient strength to allow substantial reduction in the guage of material required.

Aluminum clad low carbon steel strips are also used to replace pure nickel in many electron tubes. This material compares favourably with pure nickel for many electron tube parts; it is also cheaper. It is more economical than nickel and its lower density gives over 20% more parts per lb. Further cost reduction is obtained by eliminating the carbonizing operation required on some nickel parts. This clad material is supplied with a matte finish that provides maximum radiation properties after parts are "blackened" by firing. The radiation coefficient of the blackened material is about 85% that of a black body.

Aluminum—low carbon steel—nickel. For some electronic tube parts the requirements call for a thin nickel layer on one side of the material. This material is a low carbon steel with 10% cladding of aluminum on one side and 10% nickel on the other. Another electronic application is a small can, such as is used to enclose transistors and other parts in electronic devices. The aluminum layer provides a corrosion-resistant surface; the nickel, a surface suitable for soft soldering.

Nickel—low carbon steel—nickel. Another ferrous base metal combination has a thin nickel layer on both sides. Primary uses for this material are found in the radio industry for tube parts, and by transistor manufacturers for nickel tabs.

Gilding metal clad steel. Clad steel bullet jackets have replaced solid gilding metal (90% copper, 10% zinc alloy) and solid cupro-nickel (80% copper, 20% nickel alloy) jackets, thus making available large tonnages of copper, zinc and critical nickel for other purposes. For this application, gilding metal is clad to both sides of a steel core. Several steel companies have produced this clad metal for small-arms ammunition. Present clad ingots of 2,000 to 3,000 lb. permit high yield of usable material in fabrication. Processes for separating the steel and copper alloy cladding permit salvage of steel and copper from the scrap.

Stainless clad copper. Stainless clad copper combines the high thermal conductivity of copper with the high temperature and corrosion resistance of stainless. The thermal conductivity of solid stainless is one of the poorest of all constructional metals, although the high temperature and corrosion-resistance properties are good. Stainless clad copper possesses a much higher thermal conductivity than solid stainless and eliminates the formation of hot spots at the point of heat concentration. Tests have shown that 25/50/25 thickness ratio of double-clad stainless on copper provides an apparent lateral conductivity higher than solid copper. This point is explained by the fact that the stainless cladding is a partial heat insulator. The heat is therefore unable to dissipate as rapidly as it does with solid copper. Cooking utensils, cooling plates, fins for space heaters and heat exchanger devices of various types are typical applications where stainless clad copper is desirable for uniform heat transfer. In other applications (such as jet engine or gas turbine components, exhaust manifolds and similar parts) the copper core is necessary to increase lateral heat flow and prevent hot spot formations that might cause cracking or buckling.

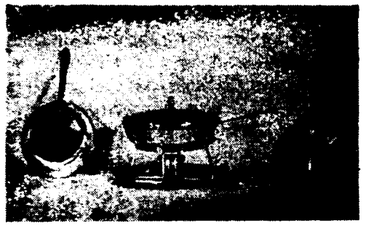
Stainless clad low carbon steel. This is a low cost combination used in applications requiring the corrosion resistance of stainless steel. In cook ware, for example, the iron core is better and cheaper than solid stainless.

Aluminum bearing alloy clad steel. There are some bearing applications where an aluminum bearing alloy is desirable but its low strength has made it unsatisfactory. Automotive bearing applications (thrust washers, bushings and split bushings) are one such group. A new clad metal consisting of aluminum bearing alloy clad to a steel backing metal provides the required strength and fatigue resistance and yet maintains the aluminum alloy properties on the bearing surface.

Copper clad hardenable carbon steel. Copper clad to one (or both) sides of hardenable carbon steel is one of the latest composite metals put into production for spring applications. This material compares with beryllium copper in many respects, but with somewhat lower fatigue resistance. The main advantage is its lower cost.

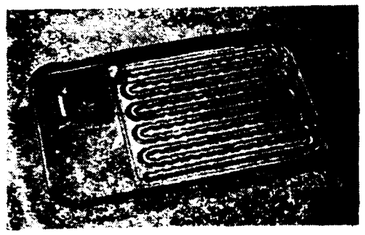
The electrical conductivity of copper clad hardenable steel depends principally on the thickness of the copper-cladding. Ratios of thickness for the copper double clad on hardenable steel can be produced to offer higher electrical conductivity than beryllium copper when the same overall thickness of materials is compared. Also, the stiffness is higher for copper-clad hardenable steel than for beryllium copper. Typical applications are fuse clips, thin blade or spiral

"The clad metals provide a new group of materials combining desirable engineering properties— many of them can't be found in single metals"

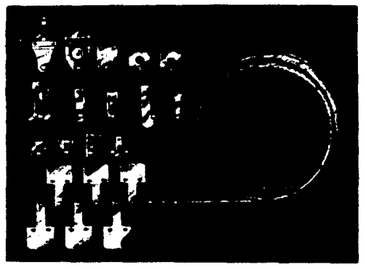


Steel-clad copper is well suited to cooking utensils.

Current-carrying springs in copper-clad carbon steel.



Cooling Plate in steel-clad copper.



Contacts improved by cladding with weldable backing.

"PHOTOGRAPHS BY METALS & CONTROLS CORPORATION", U.S.A

type springs and clips used for electrical connectors not subjected to frequent arcing. In other applications (such as pen and pencil clips) the thin layer of copper provides a good surface for decorative electroplated finishes. In these instances, the thickness of the copper cladding layer need only be as thick as 5% of the overall thickness of the material.

FURTHER EXAMPLES

Other clad metal materials. Zirconium, titanium, tantalum and other similar rare metals are characterized by excellent corrosion-resistance, a high melting point, light-weight and other properties that make them preferable for specific applications. Their use has been limited, however, because of high cost and the difficulty of joining them. Some precious metals clad to steel are still in the development stage. Titanium clad steel, for example, has only been fabricated in small experimental amounts. A composite, consisting of the rare metal bonded to common base metal, provides a material tha preserves the surface qualities of the rare meta lowers the over-all cost.

Platinum, gold, silver and their alloys clad to les expensive and stronger base metals have been used b the art and jewelry industries for many years. Thes materials are finding increasing use in industr for crucibles, electrical contact applications an similar uses.

Today, a large proportion of electrical contacts ar fabricated from composite materials. Considerabl savings in cost through precious metal conservatio are obtained; the steel (and other backing materials also provide desirable properties. For instance, button type contact, with a steel or monel backing facilitates projection welding of the contact to it supporting member.

While optimum cost may be the principal goal in the selection of a specific thickness ratio of precious metal to base metal, in many cases the backing material provides functional properties, such as spring characteristics, rigidity and magnetism.

Finally, mention should be made of brazing alloys clad to ferrous base metals. Cladding of this material is a rather noteworthy development of interest to production men. The separate handling of small pieces of brazing alloy is eliminated by fabricating parts from materials that have the brazing alloy preclad to the brazing surface. The brazing alloy and parent metal are bonded and rolled in a manner similar to the manufacture of other clad materials. The advantages of having the brazing alloy supplied as an integral part of the material is quite obvious; primarily it eliminates the separate fabrication of small pieces of brazing alloy, (as well as the handling of these pieces during the brazing operation) and decreases the number of surfaces to be joined.

Many of the ferrous metal combinations discussed have been produced to meet special applications; many other ferrous metal combinations will undoubtedly be manufactured and marketed as engineering demands them. A few additional combinations have been produced. One of these is nickel clad iron for devices based on the magnostrictive principle. In applications of this material, a clad metal sensitive to the magnetic field is substituted for one bearing heat sensitivity.

With all the metal combinations now possible in sheet, tubing and wire, it would be worthwhile to study present metal applications (as well as future product designs) to determine whether a clad metal will reduce material or fabricating cost, provide a combination of engineering properties otherwise unavailable, conserve a critical metal or improve the characteristics of a product.

U. S. LOANS FOR INDUSTRIES

MR. S. P. JAIN'S MISSION

Mr. Shanti Prasad Jain, the well-known Indian industrialist, told the *Journal of Commerce* that he is in the United States to seek loans for industrial expansion in his country.

Mr. Jain, Chairman of the board of *The Times of India*, also said he had arranged talks with American producers about the possibility of their setting up new plants in India, the *Journal* reported.

Mr. Jain said he plans to discuss in Washington a proposed £ 10 million loan for the setting up of paper and fertiliser plants in India. He explained that he had arranged talks with officials of the International Finance Corporation (IFC).

IFC spokesman said that the lending organisation was prepared to discuss specific projects with Mr. Jain. IFC makes loans for development projects in conjunction with private capital.

Mr. Jain also told the *Journal* that he plans to visit several American cities to outline to U. S. industrialists the advantages of placing new plants in India.

*** *** ***

QUALITY CONTROL UNIT AT COIMBATORE

A course on statistical quality control for engineering industries, conducted by the Indian Statistical Institute, quality control unit, Coimbatore, was inaugurated by Shri G. R. Damodaran, President, Southern Indian Engineering Manufacturers' Association.

Speaking on the occasion, Shri Damodaran said that the industries in this region had long felt the need for getting personnel trained in the application of quality control methods. The present course with the assistance of Dr. William R. Pabst (jr.) United Nations expert on statistical quality control would go a long way in meeting this need.

Dr. Pabst, in his address narrated the quality control applications made in various industries in India like rubber, aluminium, pottery, radio, cigarette, and textile machinery. These applications, he said, had resulted in benefits like increase in the efficiency of the machines better quality of the outgoing product, and reduction in the cost of manufacture. He emphasised that quality control should be viewed as a management too. Dr. Pabst hoped that the trainees in the present course would make valuable applications in their own plants.

Prospects of Gallium Industry in India

By Dr. Indra Sanghi, M. Sc., Ph. D. (Dunelm) A. R. I. C. (Lond.) F. I. C., Dip. Admn.
&
P. V. S. Subramanian, B. Sc.
(Central Electrochemical Research Institute, Karaikudi)

INTRODUCTION

GALLIUM is the first element to be discovered by the aid of its spark spectrum and the first of the three 'eka' elements suggested by Mendeleev. Discovered in 1875 by Lecoq de Boisbaudran gallium is widely distributed composing about 0.0010—0.0015% of the earth's crust.

Besides its use as a filler for high temperature thermometers to measure temperatures upto 1000°C, the various other uses to which gallium is put include its alloying with nickel and silicon for use as a dental alloy being non-toxic; preparing exceptionally strong and standard alloys; in lettering glass surfaces; as mirror backings; excitant in phosphors for fluorescent lighting and in minor amounts in selenium rectifiers. Further the gallium-aluminium alloy can effectively replace mercury in ultra-violet ray lamps the therapeutic effect being further increased by small additions of cadmium, bismuth or mercury. The most modern uses suggested for gallium are the use of the ratio-active isotope Ga72 in the diagnosis and treatment of bone-cancer and as a heat exchange medium in nuclear energy applications.[1] Intense gallium X-rays are employed in micro radiography and diffraction investigations.[2] In addition, the use of gallium chloride in Friedel-Craft's reactions is well known. But the limiting factor in the application of gallium has been its non-availability in commercial scale. A greater number of other important applications would immediately result if suitable cheap methods of production are investigated and worked out successfully.

For a number of years prior to World War II, there was some production of gallium in Germany from germanite ore and as a byproduct from copper refining. It was during the 30's that Aluminium Company of America investigated processes for removal and recovery of gallium from the sodium aluminate solution in the Bayer alumina plant in St. Louis, Illinois. Since 1946, most of the gallium is produced by the Eagle-Picher Company and the Aluminium Company of America. Production in the U. S. is estimated at 200 lbs. only for the year 1948.[3] The price of the gallium metal was as high as $ 50 per g. but by the beginning of the second World War it had come down to $ 2—4. The present price in the U. S. is $ 3.00 per g. However, large scale production could conveniently lower the present prices.

MAIN SOURCES OF SUPPLY

The richest mineral source of gallium is a complex zinc-copper-aluminium-germanium sulphide, germanite containing 0.5% to 1.2% gallium. Coal ash contains upto 0.05% and flue dusts upto 2%. Zinc ores, especially sphalerite contains on an average 0.005% (i. e., between 0.001 to 0.02). Bauxite is the most commonly occurring mineral with a gallium content of 0.002 to 0.008%. In India the manganese deposits in Kandri and Mansar mines in Nagpur district contain mixtures of bauxite and psilomelane. Several specimens of mica in Nagpur district also showed the presence of gallium.[4] Analysis of various samples of Indian bauxite reported by A. Majumdar and P. B. Sarkar[5] showed a gallium content of 0.0017 to 0.007%. Their results by the calorimetric method are found to be practically concordant with B. Mukherjee's results of spectroscopic analysis. The gallium content of Indian bauxites from various places is tabulated below.

Bauxite No.	Locality	Chemical method (calorimetric) % Ga.	Mukerjee's results. % Ga.
291	Salgipat, N. Lohardaga, Bihar.	0.0017	0.002
5038	1 mile N. W. of Dhagarvadi, Kolhapur, Bombay.	0.0023	0.0026
797	Yelurgarh, Fort, Bombay.	0.00275	0.003
788A	N. W. of Radhanagari.	0.00415	0.0043

Bauxite No.	Locality.	Chemical Method (Calorimetric) % Ga.	Mukherjee's results. % Ga.
737	N. E. Amarkantak, S. Rewah.	0.0033	0.0035
4696	Katni, Jubbulpore.	0.00565	0.0055
1128	Surganj State.	0.0074	0.007
1142	— do —	0.0077	0.008
5100	Salal, Riasi Tehsil, Kashmir.	0.0071	0.007

The extreme low percentage of gallium as shown above constitutes the main problem of economic extraction.

DISTRIBUTION OF BAUXITE IN INDIA

In India bauxite reserves exceed a total of 25,000,000 tons and the laterite cappings on the west side of the Ranchi district and the adjoining highlands of Palamau district constitute the most important deposits with a reserve of 10,000,000 tons. The distribution of these reserves is as follows :[6]

State.	Districts.	Reserves. (Tons)
1. Bihar	Ranchi & Palamau	9,000,000 (approx.)
2. Madhya Pradesh	Surguja—Jashpur-Bilaspur	6,374,000
	Balaghat-Mandla-Kawardha	2,135,000
	Bilaspur-Shahdol	620,000
	Jabalpur	525,000
3. Bombay	Belgaum	670,000
	Kolhapur	2,142,000
4. Madras	Salem—(Shevaroy hills)	2,000,000
5. Mysore	Bababudan Hills	100,000
6. Orissa	Sambalpur-Kalahandi	200,000
7. Kashmir	Jammu and Poonch	2,000,000 (approx.)
	Total	25,766,000

A map showing the distribution of bauxites and the location of major processing companies is given.

Aluminium industry is already well-established in India and is further going to be expanded during the Second and Third Five Year Plans. The present demand for aluminium has been estimated by the Planning Commission at 16,000 tons per annum and the present production of aluminium in India is 4000 tons per year. During 1949—53 the annual production of bauxite in India averaged 61,668 tons and during the same period consumption of bauxite by the domestic aluminium industry averaged 18,857 tons.[7] The plant of the Indian Aluminium Company will soon be producing 12,000 tons of alumina consuming 30,000 tons of bauxite, over 1000 tons of caustic soda and substantial quantities of lime and fuel oil in the process annually.[8]

USUAL EXTRACTION PROCESSES

From germanite: The methods of obtaining gallium from germanite involve conversion of germanium and gallium to chlorides and separating the more volatile $GeCl_4$ by distillation and recovery of gallium by electrolysis.

J. S. Thomas and W. Pugh[9] have reported a method of extracting gallium from the accumulated residues of germanium extraction.

From zinc ores: One of the methods suggested for producing the metal from zinc ores involves the following steps. First the ore is leached with sulphuric acid, a preliminary purification is done and subsequently leached with hydrochloric acid. Then ether separated and iron is removed by precipitation with NaOH and finally the caustic soda solution is electrolysed using a platinium anode and a copper cathode at 0.5 amps./cm² for anode and 0.33 amps./cm² for cathode, the voltage being 5.5.[10]

Other methods available are:—(1) Where a chloridizing roast is used for the zinc sulphide concentrates most of the gallium is volatilized and finds its way to the cadmium recovery plant where it is recovered usually along with germanium. (2) If a chloridizing roast is not used, the gallium remains behind in the retort residues from which it may be recovered by resolution and electrolysis.[11]

From bauxite: The most advantageous method of production of gallium appears to be the electrolytic deposition of the metal from the Bayer aluminate lyes. Most of the dissolved alumina in Bayer process may be separated by precipitation from the

super saturated Bayer solution. The gallia can then be coprecipitated with the remaining alumina by neutralisation with CO_2 to obtain a gallia-rich concentrate. This concentrate is dissolved in caustic soda and electrolysed at temperatures near the B. P.[11]

Hoffman[11] at the Bureau of Standards has reported a purity of 99.999% for gallium purified by fractional crystallisation as the final step after extraction of the metal from Bayer liquor.

Most of the methods above cited require electrolysis at one stage or other and the metal obtained has to be purified further.

Of the methods described for the extraction of gallium from *germanite* none yields gallium in a reasonable time. All the methods make use of acid to decompose the ore and the gallium must be separated subsequently from large quantities of copper, iron, lead and tin. Also it has been found that these methods fail to extract gallium completely. So F. Sebba and W. Pugh[12] suggested a method which is quick and easily employed on a large scale and gives much larger yields and this method makes use of alkali digestion. They studied the condition for the successful electrodeposition of quantities of the order of 10 g of metal from germanite and they found that the metal obtained in this way contained traces of lead, tin and platinium and these can be removed by simple washing with hydrochloric acid and nitric acid. The Central Research Laboratory of D. S. I. R. in Great Britain worked out a new technique for extracting gallium from flue dusts and coal ashes and tried out on a semi-commercial scale. High purity gallium has been produced at the Naval Research Laboratory by a modification of the Kryopoulas Technique of zone purification and single crystal growth and the total impurity content after purification by this method was only 0.001%.

All the methods hitherto employed for the extraction of gallium from Bayer leaches of the aluminium industries depended largely on the preliminary acidification of the lyes. Thus it can be seen that the leaches are no more alkaline and cannot be reused in the cycling process of dissolving more alumina in the ore. But the economy and operating costs of the Bayer's bauxite process depend on the reuse of 20% or more concentrated alkaline liquor again and again for treating fresh bauxite ore to dissolve it.

Hence it will be seen that the main difficulty in extracting gallium from Bayer leaches has been that there was no method by which gallium could be extracted without rendering the Bayer leaches useless for further cycling in the aluminium extraction process. However, recent work has shown the possibility of an electrochemical method although previous attempts had failed. Francis C. Frary[13] has dealt with a method of electrolytic extraction of the metal from minerals containing both Ga_2O_3 & Al_2O_3.

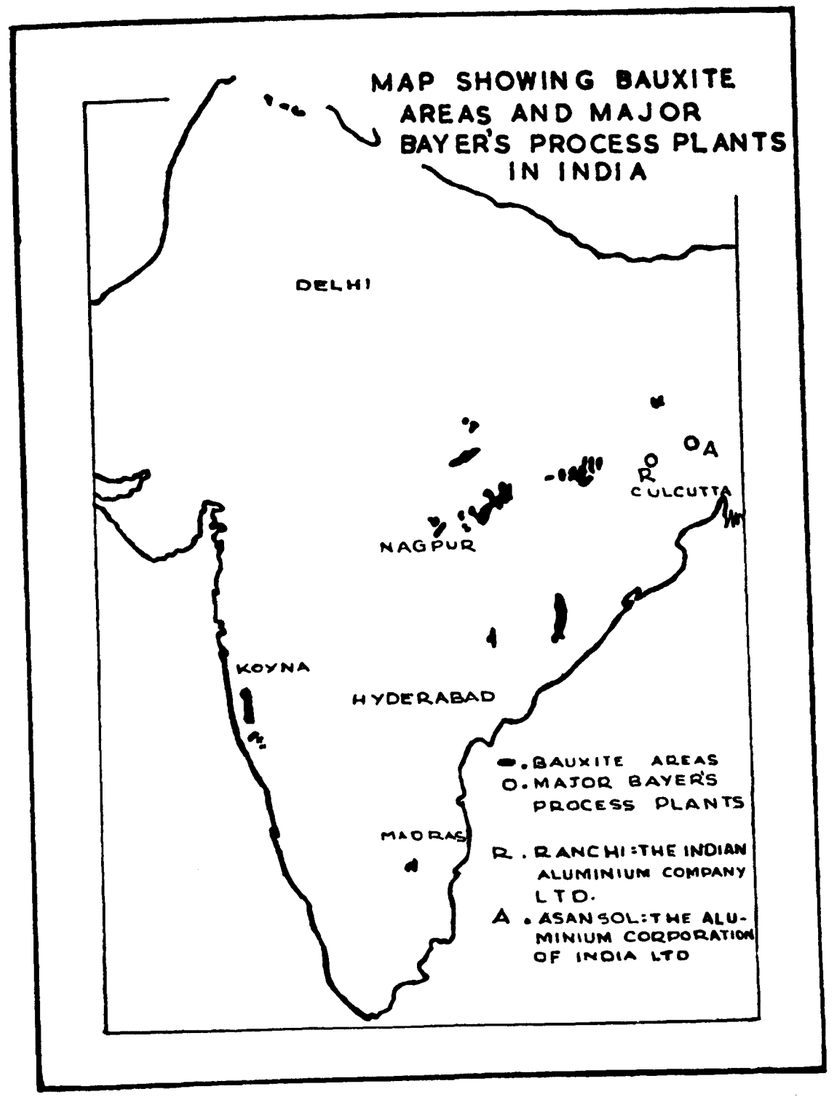
Again Ralph W. Brown[14] mentions a method of extraction from alkali aluminate solutions and he found that for satisfactory electrolysis an aluminium-gallium ratio of at least 25 : 1 should be present. P. A. Reznyak and Z. V. Mironova[15] suggest a method of extraction from the waste products of aluminium industry.

This opens up new prospects and possibilities and urgent attention of research and industry is required in this connection to take advantage of it. Moreover, even if the bauxite containing only 0.005—0.008% gallium, the Bayer leaches due to their repeated use build up an optimum concentration which may be as much as 0.5% of the leach. However, no exact details and data were so far available and from a recent private communication it was found that the industry itself had no idea of the amount of gallium in their leaches. Therefore a preliminary study of the Bayer's leaches is being made and initial experiments show that the Bayers leaches contain 0.05% gallium. The method that seems to be hopeful and having industrial possibilities is based on the work done by Pierre de La Breteque[16] in 1956 and in brief is as follows :

Electrolysis of the Bayer leaches using mercury cathode and nickel anode at a temperature of 40—50° with a cathode potential of 1.9V (cf. hydrogen electrode) and a total cell voltage of 3.8V and the current density at cathode and anode being 0.45 amp/dm² and 20—60 amp/dm² respectively, yields gallium which is further purified by a second electrolysis using a gallium cathode and nickel anode.

Although such a method has not so far been tried in India commercially, it gives fresh hopes of electrolysing Bayer's leaches under suitable conditions. However, many further improvements over the method of La Breteque may be designed as to avoid the cumbersome process of stirring mercury vigorously and the use of large quantities of mercury. Some of such possible improvements are under study and trial in this Institute.

It is hoped that the interest of the industry would be aroused and awakened towards stopping the waste of gallium in the Bayer leaches and towards the expeditious utilisation and exploitation of the available natural resources of bauxites in India by founding a gallium industry.



REFERENCES

1. J. Chem. Educ. U. S. A., Vol. 29, p. 166 (1952).

2. Nature, Vol. 168, p. 471 (1951).
3. Rare metals Hand Book, p. 149, 1954.
4. Current Science (India) Vol. 17, p. 87, 1948.
5. Science and Culture, Vol. 13, p. 75, 1947.
6. India's Mineral Wealth—p. 260, 1955.
7. Indian Minerals—Vol. 9, p. 217, 1955.
8. — do — Vol. 10, p. 88, 1956.
9. J. Chem. Soc. (London), Vol. 125, p. 816, 1924.
10. Rare metals Hand Book—p. 149, 1954.
11. J. Chem. Educ. U. S. A.—Vol. 29, p. 164, 1952.
12. J. Chem. Soc. London, p. 1371, 1937.
13. C. A. *46*, 1952 3430[i] U. S. Patent.
14. — do — 3431[a] U. S. Patent.
15. C. A. Vol. 36, p. 5448[2], 1942.
T svetnye Metal, 1940, No. 12, 60–4
16. J. Metals, Vol. 8, 1528, (1956)

POLYCHEM LTD.

The Chairman of polychem Ltd., Shri Ramdas Kilachand has struck an optimistic note with regard to the results during the current year 1958—59. Presiding over the annual general meeting of the company, he revealed that since the start of the operations in May 1957, the plant was working smoothly round the clock.

All STYRON products under the Co.'s agreements with The Dow Chemical Company have been successfully manufactured in the Plant and all these have been received very well by the Industry and Trade. The Government of India have now banned all imports of Polystyrene Moulding Compounds which is indeed a welcome step. He expressed hope that the demand of Company's products will grow more steeply hereafter. The capacity of the Plant, which during the year under review, could not be utilised beyond 50–60 per cent of the rated capacity due to large foreign stocks, is now expected to be utilised on an increasing scale during the current year.

The Co.'s 'High Impact Polystyrene' is now in large demand because of its remarkable properties. Efforts are being made to step up its production. To this end, the Directors have recently taken the decision to augment the facilities at the Plant so as to ensure larger output of this product.

In view of the increasing demand for Plastic Sheet for many industrial and consumer applications, the company is installing the STYRON Sheet Extrusion Plant. The Sheeting Plant will consume Impact STYRON as its raw material and it is hoped that as a result of this expansion the Plant output will be

The Company is actively associated with the Export Promotion Council for Plastics Industry and has undertaken to offer its products at the competitive C. I. F. prices to Indian Moulding Industry to enable it to compete in Export Markets. Efforts are also being made to explore possibilities for export of some of the Co.'s Moulding Powders directly as an index of an effort in helping the Government in its export drive. While trying to meet the industry's raw material requirements, he expressed the hope that adequate expansion of moulding and fabricating capacity would also be permitted simultaneously.

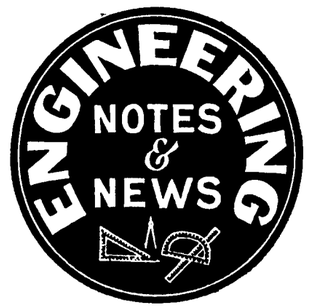
⁂ ⁂ ⁂

OIL BOARD CHAIRMAN—
MR. FEROZE GANDHI APPOINTED

Mr. Feroze Gandhi, M. P., has been appointed Chairman of the Board of Directors of Oil Refineries India (Private) Limited, the corporation which will manage the refineries to be set up in the public sector to process the oil obtained from Assam and other oilfields in the country. The corporation will have a capital of Rs. 22 crores.

Meanwhile, Mr. J. M. Shrinagesh, has taken over as Officer on Special Duty in the Department of Mines and Fuel, to undertake preliminary work in connection with the Gauhati refinery. He will be designated General Manager of the Corporation when it comes into being.

Mr. K. C. Neogy, who recently retired as member of the Planning Commission, is understood to have been appointed Chairman of the State Trading Corporation, a post till now held by Mr. K. B. Lall.



RECENT VISITORS TO FRANCE

Mr. U. Tin, Minister for Trade Development of Burma, met with representatives of a number of industrial companies during his stay in France.

Dr. Rassa, Director General of the Society of Chemical Industries of the Plan Organization in Iran, was particularly interested in the realizations of various branches of the French industry which furnish equipment for plant installations.

Mr. Carlos R. Christen J., Assistant Director of Railroads in the Ministry of Fomento of Peru, met at length with technicians of the S. N. C. F. and visited some of the installations of the latter.

Mr. Leonard Knoch, Professor at the Polytechnical Institute of Danzig in Poland, visited France to study French developments in short-wave technics and met with specialists from industry in several plants.

⁂ ⁂ ⁂

552,000,000 PASSENGERS ON THE FRENCH RAILROADS IN 1957

The S. N. C. F. transported a total of 552 million passengers, including 295 million suburban commuters, in 1957 as against 526 millions in 1956 and freight traffic rose from 204 million tons in 1956 to 217 millions in 1957.

Between Paris and 100 other French towns, trains now maintain an average speed of more than 62 miles per hour. The record is held by Express No. 605 on the 23-mile run between Macon and Bourg which is covered in 17 minutes or at an average of 80-3/4 miles per hour. Since June, the "Mistral" makes the Paris-Dijon run at an average per hour of 80-½ miles. The S. N. C. F. is continuing with the electrification of the French railroad system and will have completed 3,780 miles of electrified track, or 42% of the entire system, by the end of 1958.

⁂

2,640 MILLION GALLONS OF WATER STORED AT AN ALTITUDE OF 7,000 FEET

The important Sassiere project which forms part of the hydroelectric improvements of the Upper Isere, will be put into service during the summer of 1959. The contract was awarded by Electricite de France in 1955 and work on the dam itself was started in early summer 1956. Situated at an altitude of 7,000 feet, the dam will form a logical barrier to the lake already existing in the center of a grandiose amphitheatre of the mountains and will be one of the highest in Europe, when completed. Hemmed in by snow during the greater part of the year, the construction site is open for work during a few months of the year only and had to be made accessible by the construction of 9-½ miles of road for a difference in altitude of barely 2,300 feet.

It was also necessary to construct another 1-½ miles of road between the dam site and the quarries, located at an altitude of 8,200 feet, where the rock for the construction of the dam is broken. The latter will require 170,000 cubic yards of rock which have to be extracted under very difficult conditions from the flank of the mountains. The equipment utilized, power shovels with a capacity of 1 to 1-½ cu. yd., were brought to the site by 15-ton trucks. The rock materials are placed by being dropped from a height of up to 130 feet and washed down under pressure.

In order to utilize the pondage to the maximum, the water intake had to be constructed below the level of the existing lake which was therefore lowered by 40 feet. It had been planned originally to drive a tunnel with a length of 650 feet, starting from the downstream end, for this. It was found, however, that the upper end would terminate in the heavy layer of silt covering the bottom of the lake so that this project was abandoned. A vertical well, 59 feet deep, was dug instead, over which was constructed a reinforced concrete intake tower, equipped with shuttered intake gates at different levels.

The work remaining consists only of the waterproof facing on the upstream side of the dam which will be constituted by a series of articulated reinforced concrete slabs. The shape and composition of the joints has been designed to provide for any settling of the rock-fill and to resist the thrust of the ice which often forms in large masses at this altitude. After the start of operation next year, the dam will impound 2,640,000,000 gallons of water.

⁂

ELECTRIC POWER FROM GAS AT LACQ

In order to transform the natural gas at Lacq into electric current, Electricite de France has decided to construct a large thermal power plant in the vicinity of the deposits. The characteristics of the plant will be the same as those of the power plants at Creil and Porcheville, recently put into operation, on the borders of the Oise and the Seine.

Lacq-Artix, the construction of which will soon get under way, will be the first thermal power plant utilizing the natural gas from the Aquitanian Basin. When completed, it will provide an appreciable boost in the total production of electric power.

The project consists of four sections which are scheduled to go into operation one every four months starting in January 1960. Each of the four sections will be equipped with a boiler unit producing 400 tons of steam per hour and a generator unit of 125,000 KW. The steam will be supplied to the turbines at a pressure of 1,778 psi and at a temperature of 540° C. The equipment has been designed so that the plant can be operated on fuel oil, if necessary.

Upon completion, the plant will be supplied with scrubbed gas from the gasoline and sulphur removal plant at Lacq. Consumption will amount to 141-1/4 cu. ft. per kilowatt hour or 88,290,000 cu. ft. per day. In full operation, each section will furnish 2,500,000 KWH.

⁂

THE LYOT AUTOMATIC MONOCHROMATIC HELIOGRAPH

At the Congress of the International Astronomical Union at Rome in 1952, the Commission on Solar Investigations designated the Meudon Observatory as the organization for liaison and centralizing of observations of the solar chromosphere by cinematographical means.

For this purpose, the Meudon Observatory carried out experimental tests of the monochromatic heliograph designed by the celebrated astronomer Bernard Lyot. The instrument makes it possible to record images of the sun, by short exposures at short intervals, in a monochromatic light corresponding to the H line of hydrogen.

The Special Committee for the International Geophysical year 1957/58 recommended intensified observation of solar phenomena during this period which coincides with a recurrence of intense solar activity, and the design and construction of an instrument were therefore entrusted to a French company.

The Lyot monochromatic heliograph is an entirely automatic instrument which consists of:

—a telescope equipped with a polarizing monochromatic filter;

—a camera for 35-mm. film with automatic advance frame by frame released by a timing relay, and a shutter controlled by a light integrator (exposure time in accordance with atmospheric opacity);

—a telescope for photo-electric centering, acting on the return mechanism of the equatorial mount and providing for automatic centering of the image in right ascension and in declination;

—an electronic integrating photometer which adjusts the exposure time and stops the taking of pictures if the sky is momentarily clouded;

—an equatorial mount which supports the apparatus described above, with synchronized drive and containing the automatically controlled return mechanism;

—a panel-type control vault, containing the thermostat of the filter, the timing relay of the exposure release, switches and dials and all of the electronic and electrical equipment.

The instrument is capable of operating under all latitudes, both in the Northern and the Southern Hemisphere. It must be mounted on a concrete base, constructed according to the latitude of the locality. Since it is designed for automatic and continuous operation, the apparatus is built for use outdoors without any other protection and is therefore completely moisture-proof and resistant to tropical climates.

⁂

CONTINUED PROGRESS IN EXPORTS FROM FRENCH EQUATORIAL AFRICA

Exports from French Equatorial Africa have continued their progress and amounted to 1,029,000 tons in 1957 versus 772,000 tons in 1956 or an increase of 257,000 tons.

This is mainly due to two economic sectors, forestry and petroleum. The timber and lumber industries have exported especially logs (mainly okoume), veneer, plywood, cut lumber, etc. and such shipments constituted 42.8% of the total. Exports of petroleum did not exist prior to April 1957 and have already reached 217,000 tons.

⁂

French Achievements Abroad

525,000—VOLT TRANSFORMERS FOR RUSSIA

After important technical and commercial negotiations held at Moscow, "La Savoisienne", transformer building plant of the "Compagnie Generale d'Electricite" has been awarded a contract by the Russian Import Services which is as noteworthy by its technical specifications as by its size. The contract concluded covers the delivery of the following equipment for the 525-KV grid of Russia:

6 single-phase autotransformers $\frac{525}{V_3}$ / $\frac{115}{V_3}$ ± 10% / 11 KV

90 / 90 / 50 MVA

with tap-changing under load for the 115-KV medium tension;

3 single-phase autotransformers $\frac{500}{V_3}$ / $\frac{242}{V_3}$ ± 10% / 38.5 KV

100 / 100 / 60 MVA

with tap-changing under load for the 242-KV medium tension.

These autotransformers are to be installed in the Moscow region and are scheduled for delivery in 22 and 30 months. The schedules are based on the time required for design and construction at Aix-les-Bains.

The tension of 525,000 volts is the highest contemplated for utilization in power transmission lines anywhere in the world at the present time. France now uses 400,000 volts which is the present limit. Electricite de France which does not anticipate the use of higher tensions, has recently started operation of the 400-KV transmission line Genissiat-Paris, equipped with 4 single-phase 100-MVA autotransformers, 220/400 KV, built by "La Savoisienne".

⁂ ⁂ ⁂

THE LARGEST IRRIGATION AND HYDROELECTRIC PROJECT OF GREECE

Two French companies, "Omnium Lyonnais" and "Coteci" (Societe Commerciale Technique et Industrielle), are presently constructing the hydroelectric project of the Megdova River in Thessaly. The work includes a concrete dam with a height of 246 feet which will impound an artificial lake holding 105,000 million gallons of water, and the construction of a powerhouse with three generator units of 40,000 KW each.

The first two units will go into service in 1960. Work was begun in 1956 and has progressed at a very fast rate. The intake tunnel is 8,860 feet long, has a diameter of 14 ft. 7-½ in. and was completed four months ahead of schedule.

Aside from being the largest hydroelectric installation of Greece, the project is especially noteworthy first through the low cost of the power due to favorable topographic and other conditions, and second through the fact that it will provide irrigation for 24,700 acres of the Thessaly plains.

⁂ ⁂ ⁂

IMPORTANT DELIVERIES OF ELECTRICAL EQUIPMENT TO POLAND AND CUBA

Societe Alsthom, as pilot-contractor of a group of French companies, has signed a contract for more than 4,000 million francs, providing for the delivery of the electrical equipment and installations for a thermal power plant of 260,000 KW at Sierssa Wodna in Poland.

Under the terms of the contract, Societe Alsthom will furnish in particular two turbogenerator units which will be the most powerful ordered up to now by Poland. The contract will be fulfilled in co-operation with Societe Stein et Roubaix for the boilers and with Cie Electro-Mecanique et Jeumont for switch gear and transformers.

Societe Alsthom will also furnish for East Havana a thermal power plant of 40,000 KW which is part of a general contract concluded by Cie Generale d'Entreprises Electriques to whom the electrification of this new urban area has been entrusted.

⁂ ⁂ ⁂

NEW CEMENT PLANT IN IRAK

A cement plant built near Mosul by Compagnie de Five-Lille has been inaugurated. The plant will produce 9,000 tons of cement per month and employs 250 Irakian workers who are housed in buildings constructed near the plant.

Another plant was built by the same company at Sarchinar and inaugurated last year. This plant furnishes the cement for the construction of dikes and dams in the North of Irak.

⁂ ⁂ ⁂

NEW SHIPS FOR BRITISH, GREEK AND NORWEGIAN SHIPPERS

Forges et Chantiers de la Mediterranee have delivered to the British New Crest Shipping Co. of Nassau (Bahamas) the shelter-type freighter "Tidecrest" of 10,500/12,500 deadweight tons, which is a sister ship of the "Wavecrest", previously constructed by them for the same company.

The freighter "King Minos" has been launched for the Hellenic Star Line. With 14,792 deadweight tons, this is one of the largest freighters built in France in recent years and is of the same design as that of the Norwegian freighter "Barfonn" which was delivered a few months ago to the Sigvald Bergesen Company. The very satisfactory performance of the latter has been stressed on several occasions in the Norwegian press. Both were constructed by Ateliers et Chantiers de France at Dunkerque.

The "Prinsdal", 13,000 deadweight tons, has been launched by Forges et Chantiers de la Mediterranee. This is a bulk cargo, destined for the Norwegian Noltzau Shipping Co., and a sister ship to several others of this type which have been recently built by French shipyards.

⁂ ⁂ ⁂

FRENCH ARCHITECT BUILDS ETHIOPIAN STATE BANK

The French architect Henri Chomette has been commissioned with the construction of the new State Bank of Ethiopia. Construction is expected to require two years. The design consists of a monumental circular structure with a diameter of 180 feet, dominated by the general administration building which will have seven stories.

⁂ ⁂ ⁂

TELEVISION-RADAR FOR BELGIUM

French designed radar equipment, the only one of its type in the world, is now being installed for traffic control at the Melsbroeck Airport in Belgium.

The wave transceiver was developed by Cie Generale de T. S. F. together with the "memory tube" which transforms the radar image into a television picture. Transmission by radio beam has been entrusted to Cie Francaise Thomson-Houston.

⁂ ⁂ ⁂

THE THIRD SPUTNIK WELL-EQUIPPED WITH VARIOUS SCIENTIFIC INSTRUMENTS

The third Soviet sputnik is equipped with a wealth of scientific instruments, making possible research in various fields. The total weight of the scientific and radio-measuring equipment, as well as the sources of electric power housed in the sputnik amounts to 968 kg., almost twice the weight of the equipment in the second Soviet sputnik and nearly 200 times the weight of the scientific equipment in the American Explorer-1 and Explorer-II.

Let us mention first of all the equipment designed for studying the geomagnetic field which was absent on the second Soviet sputnik. The very origin of the geomagnetic field is unknown to science. There are also many obscurities as to the causes of the periodic changes of the magnetic field and the sudden "magnetic storms".

Other instruments installed for the first time on a sputnik may help to find an answer to these questions. These instruments are designed for measuring of the concentration of positive ions in the upper layers of the atmosphere and also for measuring the value of the electric charge of the sputnik and the tension of the electrostatic field of the Earth. Scientists suppose that there are in the ionosphere constant electric currents, the flow of which is disturbed from time to time by streams of particles coming from the Sun (called corpuscular radiation) which cause magnetic storms.

Of very great interest is the study, with help of instruments on the sputnik, of meteoric bodies,—solid particles which are continuously invading the atmosphere of our planet. Scientists think that the tiniest particles, micrometeors, exert an influence on many processes taking place in the upper layers of the atmosphere. A study of the bigger meteors is of great significance for ascertaining the scope of the "meteoric danger" threatening future spaceships.

⁂ ⁂ ⁂

INSTRUMENTS FOR THE STUDY OF COSMIC RAYS

Instruments for the study of the corpuscular radiation of the Sun and cosmic rays were installed in the third Soviet sputnik, just as in the second. It is known that investigations already made with the help of Soviet and American satellites have brought to light a number of entirely new, unexpected phenomena in this sphere. The third sputnik is helping to check new hypotheses of scientists. The study of cosmic rays will enable researchers not only to penetrate more deeply the mysteries of the origin of the universe but also to solve major problems connected with ensuring the safety of interplanetary travel.

The instruments placed in the sputnik are transmitting to the Earth data on the temperature inside the sputnik and on its surface. It is remarkable that to ensure the normal functioning of the equipment the temperature within the sputnik is regulated automatically. Such a task was set already by our famous scientist K. Tsiolkovsky and is of major significance for ensuring normal conditions of life for passengers of future spaceships.

Lastly, solar batteries are an interesting feature of the 3rd sputnik. These batteries, transforming solar energy into electric energy, prolong considerably the operation of the equipment. The first solar batteries are the prototype of gigantic solar electric stations which will serve the needs of inhabited "cosmic islands" of the future. An important role is played by a timer device which controls the work of the equipment, making possible the economical use of electricity.

⁂

RADIO TRANSMITTERS OF MUCH BIGGER SIZE AND CAPACITY

While the radio transmitters in the small American satellites can emit only weak signals, the size of the Soviet sputniks made it possible to carry radio transmitters of big capacity. This, just as previously, enabled the broadest sections of scientists and radio-fans to receive the radio signals of the third sputnik.

As for the significance of the launching of the 3rd sputnik for solving problems of space travel, we should first of all stress the fact that Soviet scientists and engineers have succeeded in surpassing their previous achievements which staggered the world and have put in orbit near the Earth an unprecedented total weight of metal shells and equipment. Future big steps in mastering outer space require the use of sputniks and research rockets of big size carrying diverse instruments.

Let us recall that the power of radiosignals received diminishes rapidly as distance increases. Hence it is clear how important it is for a rocket sent to the Moon or in general far from the Earth to have on board powerful radio transmitters, and for this it must be of large size. The launching of the 3rd huge Soviet sputnik proves the possibility of still greater progress in the mastery of outer space by man.

⁂

PENETRATING THE SECRETS OF THE MICROWORLD

The synchrocyclotron can be called the heart of the Laboratory of Nuclear Problems of the Joint Nuclear Research Institute. This enormous atomic machine whose electric magnet alone weighs 7,000 tons accelerates protons to the energy of 680 million electron volts. It is around the accelerator that all the numerous groups of experimenters concentrate their investigations.

⁂

INTO THE DEPTHS OF THE ATOMIC NUCLEUS

Seventeen different beams of protons, neutrons, and mesons are now obtained on the synchrocyclotron. By "bombarding" the targets of specially selected elements with particles the scientists are studying the resultant nuclear processes. The interaction between the accelerated particles and the atomic nuclei of the targets offers the investigators very rich material.

With the aid of the accelerator scientists study the interaction between the elementary particles themselves, between two protons, between a proton and a nuetron, and that between elementary particles and more complex nuclei—deuterons, nuclei of lithium, beryllium, carbon, etc. By observing the processes of scattering some particles by others and the birth of new particles occurring during the collisions physicists obtain not only qualitative, but also, what is particularly important, quantitative data on the nuclear forces acting between the particles, the sizes of the nuclei and the particles themselves, etc.

These data enable them to learn the structure of the microworld, penetrate into the secrets and find new ways of mastering the nuclear forces and using them for the good of man. Science does not yet know any other method of penetrating inside the particles.

The studies of scientists proceed in several directions and are of stupendous significance. A group of workers headed by V. Sidorov is studying with the aid of heavy-layer photoplates the processes evoked in the photoemulsion by protons with the energy of 9,000 million electron volts, produced in the proton synchrotron of the institute.

⁂

NEW METHOD OF PRODUCING HEAVY WATER

U. K. PLANT WILL CUT OUTPUT COSTS

A new method of producing heavy water, details of which have just been disclosed at the Geneva atoms-for-peace exhibition, may change the whole course of atomic power station development.

Particularly economical and attractively simple atomic furnaces for power stations can be designed using heavy water as a moderator—the material used to slow down the fast-moving atomic splinters thrown out by uranium atoms as they split.

The Canadians are, in fact, basing their own atomic power station design on furnaces of this kind using heavy water. But they have one serious drawback—heavy water is costly. The cheapest available at the moment is that offered for sale by the United States Atomic Energy Commission at £ 30 per kilogramme.

The new plant, designed by engineers of a British company (John Brown Ltd.), should be able to produce heavy water at one-third this cost.

The high price of heavy water is due to the difficulty of separating it from ordinary water, for the heavy form of water, although it is present in all natural waters including the seas, exists only as a minute proportion.

It is the first stage in the extraction process that is the most difficult and expensive. Heavy water and ordinary water are chemically identical, and the only possible way of separating them is by their difference in weight.

⁂

GAS FROM FERTILIZER WORKS

The John Brown process starts not with water but with "ammonia synthesis gas"—a mixture of hydrogen gas and nitrogen gas used in fertilizer and chemical factories for the manufacture of ammonia. Hydrogen in the synthesis gas consists (as does all natural hydrogen) of two kinds: a majority of ordinary hydrogen and a small proportion of heavy hydrogen.

Heavy hydrogen is twice as heavy as ordinary hydrogen. The way of separating heavy hydrogen is to liquify the mixed gases and distil them. This is difficult because hydrogen has to be cooled to exceedingly low temperatures before it will liquify.

The John Brown process uses another method. The synthesis gas is sprayed with liquid ammonia—not the ordinary house-hold ammonia but actual ammonia gas, which is compressed and cooled until it turns liquid.

Part of the heavy hydrogen in the synthesis gas changes places with the ordinary hydrogen in ammonia so that liquid ammonia gradually accumulates more and more heavy hydrogen. After it has reached 23 times the normal concentration, it is transfered to another part of the plant and concentrated further by distillation.

One of the attractive features of this new process is that it can be operated in conjunction with any ammonia plant. The "synthesis gas" depleted in heavy hydrogen is still perfectly suitable for making ammonia.

The new plant is bound to attract interest from every country with ideas of designing and building atomic power stations of its own. And, of course, heavy water is easily converted into heavy hydrogen, which is the fuel used in ZETA (Zero-Energy Thermonuclear Assembly) and the hydrogen-powered electricity generating stations of the future.

⁂

DEMAND FOR BRITISH CARS GREATER THAN EVER

MANUFACTURERS PREPARE FOR MOTOR SHOW

At a time when the demand for British cars is greater than ever before and production is running at record levels, British manufacturers are preparing for one of the most celebrated events in the international motoring calendar—the Motor Show at Earls Court, London, from October 22 to November 1.

The show, which will be opened by the Home Secretary, Mr. R. A. Butler, brings together a vast range of motor products of about 530 exhibitors. Attendance at this year's show is expected to equal, if not exceed, the figures of 1957, when paid attendance amounted to 483,500, in addition to nearly 17,000 oversea visitors. Countries exhibiting include Britain, Canada, Czechoslovakia, France, Germany, Italy, Sweden, and the United States. For the first time, models from a Netherlands factory will be on show.

By the end of June this year, more than 250,000 British cars had been exported—over 40,000 more than in the previous record half-year of 1955, representing an all-time record value of £ 95,000,000.

Joining the car exhibitors at the Motor Show will be caravan, motor-boat and equipment manufacturers making a bed for home and oversea business.

A special service is being organized for oversea visitors to the Motor Show. On production of passports, they will obtain free admission to the show.

⁂ ⁂ ⁂

U.K.'s ATOM POWER PROGRAMME LEADS THE WORLD

"FRIENDLY ATMOSPHERE" AT GENEVA TALKS, SAYS COCKCROFT

Britain leads the world in nuclear power generators and has a "much more ambitious practical power programme in hand than any other single country", according to Sir John Cockcroft, leader of the British delegation to the atoms-for-peace conference now being held in Geneva.

Sir John said (according to an agency message from Geneva on September 7) that Britain had captured the lead because of her urgent need to develop new fuel resources.

He added: "In other fields of atomic energy—for example, the use of radioisotopes—we have also established a leading position".

Commenting on the Geneva conference, Sir John said: "In the main, the reports presented have been in line with known trends. On thermonuclear research it is clear that similar lines of research are being followed in Britain, the U. S. A. and Russia, and we are all at a stage where common problems have arisen.

"Already we have amassed information which is going to give scientists and nuclear engineers food for thought and study for a long time to come".

⁂ ⁂ ⁂

BRITAIN MAY LAUNCH ATOMIC SHIP BY 1965

MODELS OF MARINE POWER PLANT SYSTEMS ON SHOW AT GENEVA

That Britain may launch a nuclear-powered merchant ship by 1964 or 1965 is the belief of Lord Weeks, chairman of Vickers Nuclear Engineering Ltd. At the "atoms for peace" exhibition in Geneva he paid tribute to the success of the American atom-powered submarine *Nautilus*, and said: "There is every reason to believe that Britain will also now move rapidly towards the construction of her first nuclear-powered submarine.

"We in Britain have concentrated on land power stations and have developed an undoubted lead in this respect.

"We are all now putting a great effort into economic marine propulsion. There is still much hard backround work to be done by industry and by the United Kingdom Atomic Energy Authority, but if all goes well there is a possibility of a practical nuclear-powered ship taking the waters from a British yard by 1964 or 1965"

Highlights of the Geneva exhibition are two models of marine nuclear power plant systems shown by Vickers Nuclear Engineering. One is the advanced gas-cooled, graphite-moderated reactor system fitted in a 65,000-ton tanker. The other sets out the nuclear room of a 47,000-ton vessel fitted with a pressurized water reactor system.

Rolls-Royce Ltd., which is associated with Vickers-Armstrongs in the Vickers Nuclear Engineering group, is showing a model and design details of the zero-energy research reactor Neptune, with which studies for the propulsion unit of Britain's first nuclear-powered submarine *Dreadnought* are being carried out.

The United Kingdom Atomic Energy Authority has invited the other 68 nations represented at the conference to send scientists on one-day trips to the thermonuclear and atomic research stations at Harwell (Berkshire) and Calder Hall (Cumberland), it is reported.

The Geneva conference, which ends on September 13, will be followed by a "get-together" of atomic scientists from Commonwealth countries at Harwell.

⁂ ⁂ ⁂

NEW ALUMINIUM ALLOY

The Argonne National Laboratory of the U. S. Atomic Energy Commission has developed an aluminium alloy which is expected to help reduce the cost of producing nuclear power.

The experimental alloy, designated X-8001, will be used as a protective jacket (cladding) for fuel elements in the Argonne Low Power Reactor (ALPR), now being built at the National Reactor Testing Station in Idaho by Argonne for the Commission's Army reactors development programme. ALPR is a prototype unit of a portable boiling water reactor for power generation and space heating in remote areas, such as the Antarctic.

Alloy X-8001, the fuel element cladding, was developed by adding small amounts of nickel to aluminium 1100, a commercial alloy which contains iron. The addition of nickel made X-8001 much more resistant to corrosion by high temperature water than commercial aluminiums having iron as the primary alloy material.

In the future, substantial savings in the operation of large-scale nuclear power plants may be possible by making use of aluminium for cladding material on fuel elements, according to officials of the laboratory. Present cladding materials, such as zirconium, are many times more expensive than aluminium and generally more difficult to fabricate and process.

(Continued on page 48)

⁂ ⁂ ⁂

MESSAGE—CARRYING SATELLITES

Earth satellites that can carry messages or mail in a fraction of the time now required will probably be developed within a few years, according to Dr. Wernber von Braun, the famous United States rocket expert. Plans for such a project are already well advanced, he says.

It is estimated that half a dozen such satellites would be enough to handle as much information as is now sent from place to place in all the mail of the world—both civilian and governmental, von Braun says.

He added that the development of such "communications satellites" is now possible because of new developments in electronics. The entire contents of a book could be recorded in a few seconds with an electronic tape recording system. Then the message could be carried to its destination in a satellite, which would relay it by radio as it passed overhead.

Dr. von Braun explained the working of a communications satellite as follows: As the satellite passed over New York, for example, its tape recorder would be triggered by a radio station that would receive what was then on the tape and would record, on the newly-cleared tape at high speed, messages, for, say, Capetown. As the satellite passed over Capetown, the process would be repeated—taking off the messages from New York and recording new messages for some other part of the world.

⁂ ⁂ ⁂

ANOTHER NEW COMPUTER

Scientists at the Argonne National Laboratory near Chicago rely on an electronic computer run by electricity drawn from atomic power to gain new information on the production of atomic power.

The device is a rapid digital calculator which can figure 200,000 separate additions of numbers per second. It is a network of electronic tubes, magnetic cores, wires and a large number of other parts big

ALL ABOUT STANDARDS

COMMERCIAL METRIC LENGTH MEASURES

The move for introduction of metric system in the country originated as early as 1867 and an Act of Government of India was passed in 1871. The Act, however, remained inoperative. The question again assumed national importance immediately after independence. In 1948, the ISI set up a Special Committee for the purpose of recommending to the Government a uniform system of weights and measures to be adopted throughout the country. Following the recommendations of that Special Committee, the Government of India decided to replace the existing weights and measures in use in different parts of the country by metric weights and measures, within a period of ten years. Necessary legislation for this purpose (Standards of Weights and Measures Act, 1956—Act No. 89 of 1956) has already been passed and steps are being taken to effect the changeover.

One of a series of Indian Standard Specifications for Commercial Weights and Measures, being prepared by the Institution, at the instance of the Standing Metric Committee of the Government of India, is the one recently issued by the ISI, Indian Standard Specification for Commercial Metric Length Measures IS : 1059-1958.

The standard prescribes the requirements for metric, commercial length measures of the non-flexible type.

⁂ ⁂ ⁂

TUNGSTEN FILAMENT ELECTRIC LAMPS

The Indian Standards Institution has just published the following two Indian Standards :

		Price
1.	Specification For Tungsten Filament General Service Electric Lamps *(Revised)* (IS : 418—1957)	Rs. 2.00
2.	Specification For Tungsten Filament Electric Lamps For Railway Rolling Stock (IS : 897—1957)	Rs. 1.50

The first standard covers the technical requirements and the methods of test for ordinary tungsten filament incandescent lamps, for general lighting purposes having a nominal life of 1000 hours, rated wattage of 15 to 1000, rated voltages of 110, 230 and 250 volts, and clear or internally frosted bulbs with standard bayonet or Edison screw-caps as set out in 3.

(Continued from page 47)

enough to fill an ordinary living room. It operates on a usual house current of 115 volts.

The instrument was fashioned to compile technological computations and mathematical deductions of research information. Argonne scientists worked three years to put the machine together.

⁂ ⁂ ⁂

RADIOACTIVE TRACERS STUDY DRUG ACTION

Radioisotopes may be used as tracers to study the action of drugs within the body, including side effects and potential new uses or hazards, according to officials of the Pfizer Therapeutic Institute in the United States.

The tremendous biological activity of such compounds as the antibiotics, vitamins, tranquilisers, etc. makes sensitive independent methods for their detection of paramount importance if their interactions with body chemistry are to be studied at "physiological" concentrations. Isotopic techniques are tailor-made for such applications.

⁂ ⁂ ⁂

The standard was originally published as IS : 418—1953 (Tentative). During the few years of its currency, the need was felt to extent its scope to cover lamps up to 1000 watts and this has been done in this revision. Another important change introduced in it relates to the measurement of individual lamp lumen in place of efficiency in determining the quality. In line with the latest international trend, as reflected in the proposals before the International Electrotechnical Commission (IEC), average figures, such as average initial efficiency, average efficiency throughout life, etc., have been dispensed with in this revision and the requirements have been based on performance of individual lamps. A number of consequential changes have been made in the clauses and tables of the standard.

Electric lamps of different ratings are being manufactured in the country, but this standard covers only lamps of the more common ratings, namely 110 V, 230 V, and of 15 to 1000 watts, which form the bulk of the demand for general lighting purposes.

The second standard covers the technical requirements and methods of test for tungsten filament electric lamps for railway rolling stock.

The designations and dimensions of the lamp caps specified in these standards are the same as those recommended by the International Electrotechnical Commission.

⁂ ⁂ ⁂

LEAD-SHEATHED CABLES FOR ELECTRICITY SUPPLY

The Indian Standards Institution has issued an Indian Standard Specification for Paper-Insulated Lead-Sheathed Cables for Electricity Supply (IS : 692—1957), which covers the requirements for impregnated paper-insulated lead or lead-alloy sheathed cables for operating voltages of 1.1, 11, 22 and 33 kV. The standard is one of a series of Indian Standards for insulated wires and cables.

Impregnated, lead or lead-alloy sheathed paper-insulated cables are being extensively used in India specially for underground installations, but up till now the entire requirement of the country had been met only by imports. Manufacture of such cables has now started in this country and this standard has taken into consideration all the special conditions of manufacture and use in this country. Particular mention should be made of the fact that in this standard both galvanized and ungalvanized steel tape armouring have been permitted though the Committee responsible for the preparation of the standard realized that in many situations in this country the ideal solution would be to use only this galvanized steel tape armour. The non-availability of galvanized steel tape in enough quantities at present has been taken into consideration.

The Second Commonwealth Standards Conference on Electric Cables, held in 1957 in New Delhi, had made a number of recommendations relating to paper-insulated cables. Such of the recommendations as were acceptable to India have been suitably incorporated in this Standard. The bending test specified in this standard is in accordance with the recommendations of the Commonwealth Standards Conference, 1957. The recommended minimum installation radii are given in IS : 1255—1958.

The standard recommends armoured cables for use, when twin and multi-core cables are laid direct in the ground. The standard temperature of 20°C, recommended by the International Standard for Resistance for Copper, has been adopted for the calculation of physical constants of plain annealed high-conductivity copper conductors. Tables giving constants for converting resistances at various temperatures to the corresponding values at the standard temperature of 20°C and reciprocals of these constants, for converting resistances at 20°C to the corresponding values at other temperatures, are included.

⁂ ⁂ ⁂

CERTIFIED SAMPLES FOR METALLURGICAL ANALYSIS

In view of the likely variations in the analytical reagents and conditions of testing, a recourse is often sought to obtain certified samples of materials for purposes of comparison and cross checking in metallurgical analysis. In recent years the demand for such samples has increased due to the industrial awareness for greater analytical control. So far these samples have mostly been imported. In accordance with the recent trend for indigenous production of materials and equipment, it is expected that certain organizations in this country would be forthcoming to prepare certified samples for metallurgical analysis.

Accordingly, with a view to assisting such organiza-

tions, the Indian Standards Institution has drafted a specification for Certified Samples for Metallurgical Analysis [Doc : SMDC 2 (101).]

The standard specifies the general conditions for the preparation of certified samples for metallurgical analysis, their analysis, packing and storage so that they may be deemed to have compositions, subject to stated tolerance, as given in a certificate to be supplied with each sample.

⁂ ⁂ ⁂

CHEMICAL ANALYSIS OF PIG IRON, CAST IRON AND PLAIN CARBON AND LOW ALLOY STEELS

Although iron and steel industry is well established in our country, various laboratories are following different methods for the chemical analysis of iron and steel. As the results reported are not always in agreement, the need was felt for prescribing standard methods.

The Indian Standards Institution had issued, earlier in 1952, an Indian Standard (IS : 228—1952) Methods of Chemical Analysis of Pig Iron, Cast Iron and Plain Carbon and Low Alloy Steels. As a result of experience gained during these years, it has been decided to issue the same as a firm standard. Accordingly, the Institution has brought out a draft revision of the standard, which is being issued for wide circulation, amongst those likely to be interested, for a period of three months with a view to securing critical review and suggestions for improvement.

The draft covers procedures for the chemical analysis of pig iron, cast iron, and plain carbon and low-alloy steels. For the purpose of this standard, low-alloy steels are intended to include steels containing chromium not more than 1.00 percent, nickel not more than 5 percent, copper not more than 0.50 percent, titanium not more than 0.25 percent, molybdenum not more than 0.30 percent, and vanadium not more than 0.10 percent.

⁂ ⁂ ⁂

SPECIFICATION FOR FERRO ALLOYS

The Indian Standards Institution has issued the following five draft Indian Standards for comments from interested persons by *13 Nov. 1958* :

(1) Ferro Vandium [Doc : SMDC 8 (79)], which covers the requirements for three grades of Ferro Vanadium.

(2) Ferro Titanium [Doc : SMDC 8 (80)], covering the requirements for seven grades of Ferro Titanium.

(3) Ferro Tungsten [Doc : SMDC 8 (81)], which covers the requirements for two grades of Ferro Tungsten.

(4) Ferro Molybdenum [Doc : SMDC 8 (82)], which covers the requirements for two grades of Ferro Molybdenum.

(5) Silico Manganese [Doc : SMDC 8 (83).] This draft standard covers the requirements for one grade of Silico Manganese.

⁂ ⁂ ⁂

ROLLED STEEL SECTIONS, BULB ANGLES

The Indian Standards Institution has just issued an Indian Standard Specification for Rolled Steel Sections, Bulb Angles IS : 1252—1958.

The standard is one of the series of Indian Standards being published under the Steel Economy Programme of the ISI. The object of this programme is to achieve economy in the use of steel by establishing rational, efficient and optimum standards for structural sections ; formulation of standard codes of practice for the design and fabrication of steel structures ; popularization of welding in steel construction and co-ordination and sponsoring of experimental research relating to the production and use of structural steel which would enable the formulation and revision of specifications and codes of practice.

The standard lays down the nominal dimensions, weight and basic geometrical properties of rolled steel bulb angles.

Bulb angles are generally used in ship building and car building industries. In the preparation of this standard, the requirements of these industries has been kept in view. An effort has also been made towards meeting effectively all the possible future demand, at the same time, without increasing the number of sections unduly.

⁂ ⁂ ⁂

LAYING AND FINISHING OF CEMENT CONCRETE FLOORING TILES

The Indian Standards Institution has just issued a draft Indian Standard Code of Practice for Laying and Finishing of Cement Concrete Flooring Tiles [Doc : BDC 8 (395)], which covers the laying and finishing of cement concrete flooring tiles in floors, walls, staircases, pavings etc. It includes the requirements for materials used in the fixing, grouting and polishing of tiles and in the maintenance of cement concrete tiled flooring.

The usefulness of tiles as flooring material consists mainly in their pleasant appearance and facility for quick installation. The appearance and the performance of the tiled flooring would depend not only on the conformance of its materials to well laid out specifications but also on the care and workmanship with which are carried out the preparation of the bedding and the laying and finishing of the tiles. It is the purpose of this standard to give proper guidance, generally suitable for Indian Conditions, for laying of cement concrete tiled flooring.

This code of practice lays down procedures for the preparation of bedding and for the fixing and polishing of plain terrazzo and special types of cement concrete flooring tiles. Special precautions necessary in finishing skirting, dado staircase treads etc. are also dealt with. The Code includes the requirements for materials used in fixing, grouting and polishing of tiles and in the maintenance of the tiled flooring.

⁂ ⁂ ⁂

SPECIFICATION FOR SAND FOR PLASTER

Sand is an important constituent of building mortar. For satisfactory performance, the fine aggregate used in the mortar should be clean, free from impurities and should have a particle size grading suited for the purpose for which the mortar is to be used, that is, whether in masonry work or plaster work, and whether for undercoat or finishing coat of plaster. Particle size grading of sand is particularly important for plasterwork ; as a delicate balance is to be struck between workability on one side, for which coarse fractions need be avoided, and strength and freedom from drying shrinkage on the other side, for which fine fractions need be minimized.

With a view to prescribe the requirements of quality, grading, sampling and testing of naturally occurring sand and crushed stone sands, used for internal wall and ceiling plastering, and external plastering and renderings, using mixes of lime, cement, composite lime-cement or gypsum (with or without admixtures) and sand, the Indian Standards Institution has drafted an Indian Standard Specification for Sand for Plaster [Doc : BDC 8 (361)]. The specification mainly relates to sand used for making mortar for plaster work. Particle size gradings for sand for internal and external plaster work have been separately.

⁂ ⁂ ⁂

COLOURS FOR BUILDING AND DECORATIVE FINISHES

Colours for building finishes are spread over a wide range, and are influenced by the material of the finish, namely, paint, distemper, tiles, hardboards, etc. The variety of finishes, coupled with the wide range of colours, has made selection of a colour or a complete colour scheme a difficult matter, both for the architect and the interior decorator. Again, selection of colours always does not lead to the procurement of the right materials having the required colours. Hence, agreement in regard to definite range of colours, covering the normal requirements of finishing and decorative work in buildings, together with information as to the colours in which each material is available, is expected to go a long way to facilitate the choice of colours and the design of colour scheme.

With a view to cover the range of colours applicable to building decorative finishes, the Indian Standards Institution has drafted an Indian Standard Specification Colours for Building and Decorative Finishes [Doc : BDC 8 (405)] for inviting comments from the interested parties by *11 November 1958*.

As a first step, the range of colours, covering different types of building finishes, has been proposed for use and reference, while fixing colours of different finishing materials. The range of colours for building finishes has been furnished in a series of standard colour cards which can be used to indicate the colour and appearance of the various parts of the building and other decorative finishes. The colour patterns are produced in a semi-gloss finish for general visual indication of colours in daylight. Further work in this direction will involve the indication of the different colours in which the finishing materials are to be manufactured. This work the Institution expect to cover in the various

specifications for building materials.

*** *** ***

MODULAR CO-ORDINATION OF DIMENSION IN THE BUILDING INDUSTRY

The adoption of modular co-ordination as a basic approach to dimensional standardization of building components and materials has been promoted in India from the commencement of standardization programme covering building materials and building construction. Since in the reduction of building costs the design aspects of buildings exert a very potent influence on cost through all the stages of construction, it has received considerable attention of architects, engineers, etc. One such aspect of design, which has been investigated with substantial success, is the rationalization of dimensions of building materials and building components. This rationalization has proceeded on the principle of establishing a simple dimensional relationship by means of a basic unit which governs the dimensions of building materials, components and of the building itself as a whole. This principle of co-ordination has been called Modular Co-ordination and the basic unit, the Module.

The word 'Module' comes from the Latin 'Modulus' meaning a small dimension. A module is a unit of measurement; it may be any number of inches, feet or centimetres and may be applied to the width, depth and height of a building component or a whole building. The module forms the basis of a three-dimensional rectilinear frame which, when used in building, ensures that standard materials and components can be used together and they will, in turn, fit into the general design layout.

In the planning of large buildings, specially offices, workshops and other industrial buildings, the architect has invariably adopted, either for convenience or for simplification, a unit of planning; sometimes it is 3 ft. sometimes even larger, 8 ft. or 9 ft. Such planning has resulted in the repetition of the same modular component and has found acceptance because it facilitates the preparation of the designs, leads to the purchase of the components on a large scale, and brings about substantial economy.

The Indian Standards Institution had adopted provisionally, as early as 1952, a 4 in. module to govern the dimensions of bricks, tiles, doors, windows, etc. This provisional decision was investigated by the various technical committees of the ISI, dealing with building materials, for the adoption of modular dimensions for items coming under their purview. As a result of this investigation, important building materials, such as bricks and stones, and building components, such as doors and windows have been covered by standards specifying modular dimensions.

Following the decision of the Goverament of India to adopt a uniform system of weights and measures based on the metric system, the Institution has adopted the 10 cm. module instead of 4 in. module to avoid confusion in the manufacture of building materials and components. Accordingly, the Institution has recommended that the adoption of the metric system and the application of the principle of modular co-ordination should proceed side by side.

For this purpose, the Institution has brought out an Indian Standard Recommendation for Modular Co-ordination of the Dimensions in the Building Industry IS : 1233—1957, which defines the basic module to be adopted for dimensional co-ordination in the building industry, and deals with its application in building design and manufacture of building materials and components.

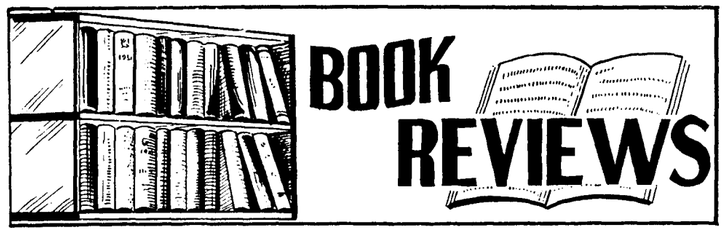
*** *** ***

NATURAL BUILDING STONES — DETERMINATION OF RESISTANCE TO WEAR BY ABRASION

The Indian Standards Institution has issued a draft Indian Standard Method For Determination of Resistance to Wear by Abrasion of Natural Building Stones [Doc : BDC 6 (399)] for the comments of interested persons by *20 November 1958*.

Natural Building Stones, used in steps, flooring and pavements of buildings, are subject to heavy wear and friction. Their durability under such circumstances can be ensured only when they have adequate hardness or abrasive (wear) resistance. This standard gives a laboratory method for ascertaining abrasive values of stones intended for use in buildings.

*** *** ***



PUMPS, FANS & COMPRESSORS

By A. DE KOV'ATS & G. DESMUR, Blackie & Son Ltd., London W. C. 2 and Glasgow, 45Sh nett, 327 Pages, Translated from the original French by R. S. Eaton, M. A., Manchester College of Science & Technology.

This book deals with the design, construction and operation of centrifugal and axial-flow pumps, fans and compressors. It has a practical bias and assumes a certain amount of knowledge of the fundamental laws of hydraulics aerodynamics, and thermodynamics.

The book will be of considerable interest and practical use to Engineers who are sufficiently informed in these three sciences and who are called upon from time to time to operate these machines.

The contents are divided into 7 Parts and 34 Chapters, and fall roughly into the following headings :—

Fundamentals, Design and construction of Impellers and Diffusers, Construction of Pumps and Fans, Pumps for Special duties, Examples, Operation of Pumps and Fans, Turbo-Compressors.

The theoretical portion is restricted to those laws which are indispensable to a complete understanding of the problems of design, but the phenomena of flow and of energy transformations which are so often neglected by classical hydraulics are discussed in greater detail.

The author has concentrated more on experimental results which have been proved in actual practice, introducing where necessary well-established empirical formulæ and tables, than on the establishment of mathematical formulæ relating to differences in the behaviour of an actual fluid and an ideal fluid in their passage through a machine, which generally have failed in the past to take into account all the physical factors involved.

The Publication is quite timely and useful for all those connected with the manufacture of Pumps, Fans and Compressors in particular and to other Engineers in Industries & Manufacturing Organisations in general.

*** *** ***

HYDRO-ELECTRIC ENGINEERING PRACTICE

Volume I, II & III—1958 (First year of publication)

Chief Editor : J. Guthrie Brown, M. Inst. C. E., Pres. Inst. Struct. Eng. (1956/57), M. I. E. Aust., M. N. Z. I. E., M. Soc. C. E. (France)

Consulting Engineer : Partner of the firm of Sir Alexander Gibb and Partners, London, Chairman of the British National Committee of the International Commission on Large Dams, Member of Qualified Engineers Panel No. 1, Reservoirs (Safety Provisions) Act. 1930, Member of Technical Panel—North of Scotland Hydro-Electric Board, Member of the British National Committee of the World Power Conference.

Co-ordinating Editors :

P. L. Blackstone, T. D., M. A. (Cantab), M. I. E. E., Head of Hydro-Electric Department of Messrs. Merz and McLellan.

J. K. Hunter, B. Sc., M. I. C. E., M. I. Mech. E., M. I. E. E., Consultant to Sir Alexander Gibb and Partners.

Vol. I—Civil Engineering— Price 9 Guineas Nett.

Vol. II—Mechanical & Electrical Engineering — Price 6 Guineas Nett.

Vol. III—Economics, Operation & Maintenance — Price 4 Guineas Nett.

Blackie & Son Ltd., London, W. C. 2, Glasgow & Toronto.

These three volumes, the only authoritative books on modern British and Continental Hydro-electric design, construction, operation, and maintenance, are the work of a team of enthusiastic engineers who are very actively engaged in hydro-electric engineering.

These volumes are of use both to the practising engineers and the advanced students and give the latest methods and techniques adopted in Great Britain, Continent and Overseas.

Volume I—Civil Engineering

This volume is divided into three main sections. There are 11 contributors to the volume :

1. Preliminary Hydraulic Considerations.
2. The Planning of the Scheme
3. Design and Construction of Civil Engineering Works.

The first two sections carry four and three chapters respectively and the third contains seventeen chapters. Most of them have extensive bibliographies appended.

Since the end of world war II, remarkable increase in hydro-electric power production has taken place in almost every part of the world and particularly in the countries which suffered an interruption in their imports of essential coal and oil during the war the development in this respect has been phenomenal.

In view of the advantage of hydro-electric power, apart from its economic values, even countries possessing large supplies of coal and oil, are harnessing the energies of natural water power for the production of electricity. Although atomic energy use for civil purposes holds out vast potentialities for the development of power resources still for several years to come production of electrical power by harnessing natural water power resources will continue.

These volumes will be the first of the kind on Hydro-electric Engineering in Great Britain although comparable books on the same subject have already been published in the United States. The time is now most appropriate for the release of a book of this size and importance and the Authors and the Publishers deserve congratulation for this venture.

These volumes are extensive on modern hydro-electric design, comprising specialised civil, mechanical and electrical engineering and full justice has been done by all the authors jointly to the work they had taken on hand.

The volumes will be of considerable use to the Practising Engineers and the advanced students and give the latest methods adopted in Great Britain, continent and overseas.

Each chapter has been carefully revised and brought upto date and these volumes would be a worthy addition to all the Libraries of Engineering Colleges, Research Centres and other connected Institutions.

NEW JAPANESE SHIP MAKES FAST RUN TO LOS ANGELES HARBOUR

One of the world's fastest cargo vessels, the M/s. KAMOHARU MARU, recently made her maiden voyage from Yokohama to the Port of Los Angeles in 10 days and 16 hours, averaging 19½ knots per hour.

The new Shinnihon Steamship Company vessel has a deadweight of 12,454 tons, is 515 feet long, has a 64-foot beam, and a cargo capacity in excess of 600,000 cubic feet.

The latter includes 15,500 cubic feet of refrigeration space and nearly 13,000 cubic feet of deep tank capacity. The latest type Cargocaire ventilating system maintains a free flow of air throughout all cargo holds and prevents damage by moisture, according to Balfour, Guthrie and Co., Los Angeles agent for the line.

The speedy KAMOHARU MARU also offers luxurious, first-class cabin accommodations for eight passengers.

BOOK - REVIEW

BRITAIN—An official Hand-book

1958 Edition

Prepared by The Central Office of Information,

London.

This reference book has been prepared by the Central Office of Information, with the co-operation of other Government departments and many national organizations. It contains factual and statistic information compiled from official and other authoritative sources. The book contains 530 pages with a comprehensive index at the end. There is also a coloured map of the British Isles. The information which it contains has been divided into fourteen sections as follows :

(1) The British Isles

(2) Government and administration

(3) Defence

(4) The National Economy

(5) Industry

(6) Transport and Communications

(7) Labour

(8) Finance

(9) Trade

(10) Social Welfare

(11) Housing and Planning

(12) Religion, Science and the Art

(13) Sound and Television Broadcasting

(14) The Press

There are two appendices : (1) British Currency, Weights and Measures and Conversion Tables and (2) Research Institutions. The attention of the reader is called particularly to the sections relating to Industry, Trade and Nuclear power.

A map of the British Isles shows the location of nuclear energy establishment in the British Isles. These power stations have been built both for the United Kingdom atomic Energy Authorities and for the Electricity Authorities. In order to extend the scope of its experimental work and produce Plutonium, a number of reactors are being built which also produce electricity on a reasonably large scale. The best known of these is the Calder Hall Nuclear energy Establishment in Cumberland which is the first large scale nuclear power station in the world to supply electricity to a national electricity net work. Calder Hall 'A' consists of two reactors and has an installed capacity of 92 mega volts. Calder Hall B is due for completion in 1958 and is expected to double the installed capacity. Similar reactors are being built in other parts of the British Isles. Britain envisages spending 300 million pounds on building 12 nuclear power stations together with all the necessary ancilliary services, Uranium and proto-type development in the ten years 1955 to 1965. By this means, by 1965, 1,500 to 2,000 mega volts of electricity would be produced, which will lead to a saving of five to six million tons of coal a year.

The great progress which is being made in nuclear energy establishments directed towards peaceful means is noteworthy.

The reference book also contains much valuable information on the organization, production and establishments of industry. On page 142 there is a map showing the location of natural resources, metals and engineering, textiles and other industries. Subjects such as Agriculture, Fisheries and Forestry, Fuel and Power and Electricity are all dealt with informatively. Many will find the section of Trade quite useful. External trade, controls and trade payment, information and advice to exporters, Export Credit insurance, Trade fairs, International trade, the balance of payments, as well as Internal Trade are all adequately dealt with.

The book contains several attractive photographs which enhance its interest.

All those who wish to know anything about Britain and to obtain uptodate and authoritative information are strongly urged to acquire a copy of this hand book.

Plant for Manufacture of Electrical Accessories from the G.D.R. in the Leipzig International Spring Fair—1959

By L. F. A.

WHATEVER the country, there is everywhere a big demand for diverse electrical accessories such as switches, sockets, plugs, adopters and various other items. All these products must conform to standard specifications and prove suitable for connecting to copper or aluminium wiring systems. There is an abundance of shapes and forms, differing in colour and components parts. In the category of switches, for example, a broad distinction is made between exposed and flush types, with a further differentiation in rotary and tumbler switches, not to mention sealed types and specialised switches.

In the course of time, natural materials for insulation have gradually come to be replaced by chemically produced substitutes the most common being resinous types of plastic that can be hardened. Generally this is a type 31 moulded plastic made up of 45 per cent phenolic resin, a few per cent dye and mould lubricant and the rest wood flour as filler. Another excellent medium for the manufacture of insulating materials is the Dicandiamyde moulding compound (DIDI-Pressmasse). For years now eases and coverings have been made from synthetic resin materials, but to this day the base of switches and sockets continues to be made of steatite.

When planning for the manufacture of electrical accessories the first question is that of the capacity of the factory in relation to its economical running. It should be pointed out that a relatively small plant may very well operate profitably. But if it is intended to manufacture steatite sockets, the plant must be considerably larger, since steatite becomes a profitable proposition only when turning out millions of items.

Under the circumstances it would, therefore, be advisable to drop the idea of steatite altogether and make these parts also from plastics, all the more because the same set of machines could be used for the purpose.

There are a number of other factors that have to be taken into account when setting up new plant, such as the choice of a suitable site, availability of adequate power resources and labour. Regarding the site the choice should always be made with the view to extension at a later date. One favourable aspect of this complex problem is the fact that for running such a place, with the exception of managerial personnel, skilled labour is not needed, only short periods of instructions being necessary. This is undoubtedly an important consideration for underdeveloped countries now embarking on a process of industrialisation.

1. Parts made from plastics :— For the handling of the plastic compound in the preliminary maufacturing process pelleting machines are needed, with a 100 ton punching power and facilities for heating the moulding tools, by electricity or steam, to a temperature of 160 degrees centigrade. For Switches, wall sockets and similar articles the usual thing is to use a multiple moulding tool, generally an eight-point tool. It should always be borne in mind that the first requisite for a reliable moulded part is a smoothly functioning moulding tool.

The finishing is to a large extent limited to the removal of burrs and, if necessary, some polishing. For plain surfaces it is best to use a belt sanding machine : for holes, drilling machines with reamer : and for long edges, files and scrapers. If it is a question of large quantities of smallish pass-produced parts these processes can profitably performed by a trimming drum. For polishing, an extra polishing machine with muslin wheel is needed.

The above-named machines will serve a variety of purposes, but of course, if a change in the production programme from one article to another takes place, the appropriate tool has to be constructed first. Therefore, if possible, care should be taken to choose an article with a fairly long run so as to operate the

machine at full capacity and avoid costly refitting operations.

2. *Parts made from Metal*:— The required parts (Primarily steel or brass—are almost entirely turned or stamped parts such items as pins, Screws and nuts are generally made on automatic machines.

A new plant would require the following equipment :—

Lever presses for stamping of parts ;

Driven screw presses for planing ;

Sanding drums for deburring ;

Automatic screw machines or cold-press automatic screw machines for the manufacture of screws ;

Automatic nut machines for production of nuts ; automatic capstand lathes for other turned parts.

In addition various other smaller machines are needed, such as wire-winding machines, thread-cutting machines and drilling machines.

Most metal parts are given a subsequent galvanic finish, a Zinc or cadmium bath. This requires the installation of an Electroplating plant. If there are parts that have to be hardened, a salt-bath hardening plant must be provided for. And finally there should be a sufficient number of line assembly tables to guarantee smooth flow of production.

Lay out of Plant:— Experience has shown that the best results are achieved with a single-storey factory building, with the moulding hall as its centre. This latter should be about 12.5 metres wide, while the length would vary with intended capacity. The remaining sections could be accommodated in an adjoining shed building.

The project should comprise of the following sections :—

1. Raw materials depot for moulding compound and pelleting section ;
2. Moulding room ;
3. Compressor room with one small low-pressure compressor ;
4. Storage room for compression moulds ;
5. Finishing room for plastic parts, prior to assembly ;
6. Storage depot for metals ;
7. Manufacturing section for metal parts ;
8. Electroplating section with poison room, for Zinc plating or Cadmium plating (For tropical climates) ;
9. Hardening room (Salt-Bath)
10. Storage room for finished metal parts ;
11. Assembly section ;
12. Storage depot for finished products prior to shipment.

Ancillary Plant:— According to size of factory and local conditions it might be necessary to add several more sections :—

1. Power Generating plant (E. G. Diesel Unit) ;
2. Tool shop ;
3. Laboratory ;
4. Sanitary and social services (Wash Rooms, Dressing rooms, W. Cs.) ;
5. Office rooms ;

As stated above the secret of good quality product and economy in operation are reliably functioning moulding and stamping tools. These are made to a very high technical standard of perfection by specialised factories in the German Democratic Republic. One question often asked is whether a plant for the manufacture of electrical accessories should have its own tool shop or not. The answer that for a factory to have its own tool shop is always of advantage so that new tools can be made on the premises. The same applies, of course to the carrying out of repairs. Only in cases where qualified labour is not available should the intending proprietor refrain from planning his own tool shop for new factories, to limit himself to repair work while making arrangements for new tools to be supplied from outside sources.

In this short article it is only possible to mention briefly some of the products of the manufacturers of electrical goods plants in the German Democratic Republic. There will be a range on show at the forthcoming Leipzig International Spring trade Fair to be held from 1st to 10th March 1959. However will include a representative and also comprehensive cross-section of their current programme, and, to add to its value, numerous exhibits from the leading makers in the Federal German Republic, United Kingdom, The Soviet Union, Hungary, Poland, Czechoslovakia and many other western countries.

New Booklet on Organic Chlorine Compounds Published

Eleven organic chlorine compounds available in commercial quantities are described in a new 45-page booklet made available by the Chemicals Department, Union Carbide International Company, Division of Union Carbide Corporation. The booklet details physical and physiological properties, application information, shipping regulations, handling and storage, and specifications and test methods for the compounds described.

The booklet, entitled *Organic Chlorine Compounds*, RF—4769B, discusses applications for the compounds as fumigants, solvents and extractants, degreasing agents, dewaxing compounds, dry cleaning fluids, and intermediates in the manufacture of other chemicals. The materials discussed are ethylene dichloride, Chlorasol fumigants and solvent, propylene dichloride, trichlorethane, butyl chloride, 2-ethylhexyl chloride, dichlorethyl ether, dichlorisopropyl ether, triglycol dichloride, ethylene chlorhydrin, and epichlorhydrin.

In addition to a detailed description of each compound, there is a general discussion of the advantages of chlorinated solvents, and of handling and storage procedures recommended for chlorinated compounds. Physical properties, physiological properties, shipping data, and specifications and test methods are grouped in tables for rapid reference. Complete instructions for test procedures are given in a 6-page section. There is also a table of constant boiling mixtures, and there are 13 charts of physical properties of various compounds and mixtures.

Complimentary copies of the booklet are available from the Chemicals Department, Union Carbide International Company, 30 East 42nd Street, New York 17, N. Y., U. S. A.

*** *** ***

UNION CARBIDE INTRODUCES TWO NEW AMINES

Two new amines, 1, 3-diaminopropane and imino-bis-propylamine, are now available from the Chemicals Department, Union Carbide International Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y., U. S. A.

1, 3-Diaminopropane, a water-white liquid which is completely soluble in water and common organic solvents, is a raw material for textile crease-resistant resins with improved scorch-resistant properties. Since the compound has bifunctional amine groups, it is also of interest as an intermediate in the synthesis of pharmaceuticals, ion exchange resins, surfactants, insecticides, rubber chemicals, dyestuffs, and corrosion inhibitors.

Imino-bis-propylamine is expected to be of particular value as a raw material in the production of textile softeners, paper-treating resins, and ion exchange resins. Its structure also suggests its possible use in the synthesis of such products as pharmaceuticals, dyestuffs, rubber chemicals, insecticides, and surfactants, and as a catalyst for polymerization reactions. This new amine is a colorless, high-boiling liquid which is completely soluble in water and common organic solvents.

Both 1, 3-diaminopropane and imino-bis-propylamine are available in commercial quantities.

*** *** ***

COLORANTS FOR UNION CARBIDE'S HIGH-IMPACT, HIGH-GLOSS STYRENE EXTRUSION COMPOUND, TGD-5001

TGD-5001 is supplied in Natural 15 as well as many colors. However, for those fabricators who desire to produce their own colored stock from Natural 15 to further increase the range of color possibilities, Union Carbide's Development Laboratories have made a careful study of pigments which are suitable for use with this compound.

When a pigment is considered for use as a colorant for TGD-5001, it is subjected to four tests: 1) Light stability tests are conducted on the pigmented compound in both indoor and outdoor weathering devices; 2) Heat stability tests are conducted on molded samples of the pigmented compound at 204, 232, 260, 288 deg. C.; 3) Samples of the pigmented stock are placed in contact with white stock at 60 deg. C. under four psi pressure to check for color migration; 4) Crocking tests are also conducted to determine the color stability. Selected pigments must successfully pass all four of these test before they are added to the list of suitable colorants.

Experience in the laboratory has indicated that concentrations of pigment vary considerably depending upon the color desired; but in most instances, it has been found that concentrations rarely exceed one to one and one-half per cent.

TEXTILES SECTION

The Flocking Unit in Large Dimensions

By An Overseas Correspondent

"WHAT are the news in circles of the flock-printing industry?" This is the question which can be heard in every part of Germany where the textile industry has it's residence.

We picked up this question as we can imagine that the interested readers will pay great attention to the development of the newest surface refinement on this field.

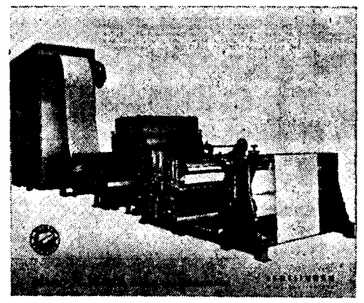
The answer is of amazing accordance: " Flockprint " could not be missed in today's surface refinement of textiles. Leading manufacturers who have been hesitating in using this new process upto now, are now requiring offers for highly efficient units. Why?....

The interested party partially will know from their own experience how much importance is paid to a really durable flock-adhesive. Also in this matter the development has not had a stand-still. Today one disposes of a finely dispersed flock adhesive which is not only boil-proved, but which distinguishes itself by being constant to the chlorinated and not chlorinated solvents used by chemical cleaning.

In order to get an objective and unbiassed report, we asked a German machine manufacturer for his opinion. We received the answer that the increased enquiries induced him to occupy himself with the construction of a highly efficient flockprinting plant in large dimensions, although this conclusion was not easy with regards to the costs of development and research-work.

Willingly we got further informations which we shall not with-hold from you, as far as these informations are of interest to you.

This continuous and fully-automatic working flocking-unit is constructed in that way that the material is passing the various stations in curved state. Owing to this attachment, a foldless feed is guaranteed.



Further more 5 pneumatic conveyor-belts take over the strainless transport between the particular aggregations, by which an irregular and exceedingly unfavourable flocking is avoided. The flocking process itself is done within the electrostatic flocking zone in double outfit, meanwhile the mechanic supplementary flocking zone takes over simultaneously the function of an effective first-cleaning. The drying mansard is constructed in spiral system so that the flocked side of the material is free of contact with the guide of deflection. The volume of the mansard is 60 yds. approx. The mansard is heated by steam. An automatic regulator is attached for the constant temperature of 150 degr. of Celsius. Furthermore it disposes of a fresh-air conveyance and air-revolution. Over a throttle-device the escape of solvent-vapour can be led. A combined-working cooling, brushing and unrolling-device finishes the flocking-process.

THE ELECTROSTATIC FLOCKING PROCESS

To achieve a velvet and velours-like charakter of surfaces.

The technique and purpose of electrostatic flock coating is to have a warm and pleasing surface on inferior materials with an unattractive appearance in such a manner that a velvet—and velours-like effect is obtained by means of an electrostatic field which is

used for the application of rayon flocks, precision-cut in standard-lengths of 0, 5 or 1 mm.

The process itself is not new. When it was first introduced, the general opinion was that this method would soon go out of fashion. It was found, however, that the advantage offered by flock printing, viz. the attractive effects and above all the economical aspects of the process, rendered it eminently suitable for industrial-scale application. Today, electrostatic flock coating or printing has firmly established itself, especially in the field of textile finishing.

The field of application does not only cover the textile industry, and German manufacturers have concluded import—and export—business by selling flocked good the attractiveness of which was their sales aid.

Here are some examples for application :

Wood.... Flocking of cases for cutlery, shelves, show-cases, boxes, toys, decorations, hasks and bobbins.

Paper.... Flocking of cardboard, wall-papers, cardboard sheets for calendars, decorative and instructional material postcards.

Glass.... Flocking of thermometers (back), articles of industrial art, decoration material.

Plastics.... Flocking of foam rubber sheets, foam rubber cushions PVC, polystyrene, bakelite, articles for decorating show-windows, pads of all kinds.

Leather.... Flocking of skins, cases for cameras and optical instruments, slippers.

Textiles.... Flocking of piece goods, fully or decoratively (cocktail and evening gowns) lastex and other girdles, shawls, pullovers and cardigans, gloves.

Metal.... Flocking of sheet boxes, linings, turn-tables for record changers.

Jewelry.... Flocking of brooches, vanity-cases, and all goods of the Gablonz industry.

Architecture.. Flocking of show-windows and show-cases, stands of fairs, cinemas, cafes and bars, decoration of rooms.

Acoustics.... Flocking of cases for suppression of interferences, natural vibrations and noise absorption.

Lighting industry.. Flocking of reflectors (outside), lampshades, sockets of desk lamps.

Office equipment.. Flocking of desk pads, office utensils.

We are always requested by our business friends here in Germany and abroad to describe new developments in the field of flocking technics and to give hints about improved methods and their application in praxis.

This request is quite unterstandable as in most cases very little is known about this special line and hardly any useful literature is available.

For this reason the manufacturer is obliged to let his client have more than the usual support for the introduction of this process. Moreover, he is to help him to overcome the first difficulties and to inform him how to remove sources of error caused in most cases by ignorance. This is also a decision factor why it is necessary that the manufacturer who is ready to take responsibility regards it as his most important task to construct his machines " fool-proof ", so that when observing the working instructions, even an unskilled workman can operate them.

It will help a lot particularly the interested party abroad and also the one in Europe in his decision to buy such a machine when he can be assured that his workmen too can handle it, so that defects in the production caused by unskilful attendance can hardly be expected.

TECHNICAL DESCRIPTION

After the electrostatic flocking process which is well-known as flock-printing has been accepted without reservation as an effective refinement of the surface, one wished to find a most possible automatic working flocking plant with an average capacity and universal use. The AWR flocking plant " BFA 58 " accomplishes this demand consistently. It is a construction of a most modern style of building which refines a closed textile material or a PVC spread on textile over-

all or decoratively. It produces a look of velvet on the treated material.

MOST ESSENTIAL PARTS

Double rolling off device.

Spread—and press-mechanism with pneumatic conveyor.

Flocking aggregate with two flocking zones and pneumatic suction.

Supplementary mechanical flocking unit with container for surplus flocs.

Spiral dryer installed for steam-heating with fresh air feeding.

Combined cooling, brushing and winding-up machine.

Main gear with longitudinal shaft.

PRODUCTION

The material is conveyed to the spread—and press-mechanism for spreading on the adhesives. It goes through two electrostatics and one mechanical flocking-zone. Five pneumatic conveyor-belts lead the material foldlessly over the plant. The drying mansard is constructed as a spiral dryer so that the flocked sides of the material are free of contact with the guide of deflection and the temperature in this mansard is regulated by a temperature-regulator. The volume of this drying-equipment takes about 60 rolling yds. With a combined cooling, brushing and winding up installation, the flocking-process is finished.

MAIN-CHARACTERISTICS

1. Feed of the material in curved state through the most important flocking sections.
2. Foldless transport of the material
3. Double electrostatic flocking with attached mechanical supplementary flocking zone which at the same time works as a pre-cleaning.
4. Four times intensified pneumatic suction.

TECHNICAL DATA (FOR A WORKING WIDTH OF 1350 MM)

Max. Length : 15 yds. Weight : 16 t
,, Width : 3.5 yds. Speed : Approx. 5 yds./min f. total flocking of the surface and approx. 10 yds./min. for decorative flocking.
,, Height : 4.8 yds.

Alternations of measure and weight with reservation.

PRE-STRESSED CONCRETE
Beams Produced Automatically

Continuous 300-foot lengths of pre-stressed concrete beams are now being manufactured in England. The total number of men required to operate the machine is four and they produce one-third of a mile of beam per shift.

The process makes moulds superfluous : the concrete is extruded from a travelling machine on to flat beds. When the beam has been cured it is automatically fed to a saw table which cuts off the required lengths. Beams, for floors or roofs or for any other purpose to which pre-stressed concrete can be put, can be cut in lengths up to 30 feet.

The beams are formed on a flat concrete bed over which the casting machine travels suspended from a gantry driven by an electric motor. The moulding section moves in short steps of about 18 in., metering out the correct amount of concrete from an overhead hopper.

The moulding section is moved by compressed air. As the concrete is poured it is vibrated between side plates which, with the concrete bed, act as a forme.

The layout of the casting shop, which has been designed by Richard Lees Ltd., of Mugginton, Derbyshire, England, allows for the travelling moulding gantry to straddle three parallel beds at the same time, one bed casting, one curing and the third being cleared and cut for length.

Prospects for Export of California Cotton to India

India would be in the market for California cotton for at least 10 to 15 years, according to an American sales executive of one of the leading shippers of cotton to this country.

THIS prediction was made by Mr. Tom Akers, Jr., of the Sales Department of Calcot, Ltd., of Bakersfield, California, in an exclusive interview with Globe Press Service.

Although India was making efforts to develop the California type of cotton here, and eventually would be successful. Akers continued, she would still require considerable shipments of American California cotton for sometime to come.

On a ten-day visit to India, after a similar stay in Japan, to study export market conditions for U. S. cotton, the American opined that India would need 600,000 bales of California type cotton for her textile mills.

He pointed out that the India's foreign exchange position would undoubtedly make it necessary to curtail to some extent her imports of American cotton. However, he was optimistic that California would supply at least 200,000 bales—in addition to what India would continue to obtain from Egypt, Sudan, and East Africa.

At least half of the California shipment (100,000 bales) would go to India through the Port of Los Angeles, Akers added. Cotton is now the leading agricultural crop in California.

Shipments of cotton rank third among commodities shipped out of this top Pacific Coast port—with Japan heading the list of California cotton importers. For fiscal 1957 (ending June 30) more than 102,000 tons were shipped overseas—an increase of 40 per cent over the previous fiscal year.

Meanwhile, shipments to India of raw cotton, through the port, have gone up steadily in recent years.

As far as the cotton export business of Calcot, Ltd., was concerned, Akers revealed that Japan was their No. 1 market for California cotton, and India was in No. 2 spot. However, he emphasized that there was a possibility of India displacing Japan, occasionally, at least, in this respect.

Akers declared, while discussing the current prospects for increased Indo-American trade, that most American businessmen personally preferred to "have India strong economically," even if it meant less business with them in the long run. In this connection, he remarked that due to one reason or another, there would "always be a chance to supply some American cotton to India"—even after she had become considerably more developed economically.

Visiting Ahmedabad, India's No. 2 textile centre, Akers inspected several mills and the Ahmedabad Textile Industry's Research Association. He described the A. T. I. R. A. as being "pretty well organized" and was impressed by the work of this institute.

While in the Ahmedabad area, Akers, who is also an agriculturist, took a first-hand look at Indian farming methods—including the cotton crop. In a reference to the food problem, he said he was convinced that "with proper organization, India can feed herself."

Dealing briefly with the activities of Calcot, Ltd., the principal shippers of quality cotton to India, Akers stressed that they were concentrating "on improving packaging of cotton by means of a fully covered bale—which is automatically sampled during the ginning process."

He added that they will produce at the gin about 70,000 bales of this particular type (gin-compressed bales) for export.

While enroute home to Southern California, Akers will tour Europe and visit some textile centres on the Continent.

The Textile Industry's Problems

By A. D. SHROFF

As the third largest earner of Foreign Exchange for the country (Rs. 76.16 crores exports in 1957–58), the Textile Industry is in the forefront of economic discussion. For instance, the industry received detailed treatment at the recent meeting of the Export Promotion Advisory Council.

THE textile industry developed sickness in September 1956 when in a reckless and irresponsible manner excise duties were increased for the second time in that year. It is a curious anomaly in India's economic situation that with such large amounts of money being spent in the Public Sector, which means the creation of so much additional purchasing power in the country, the industry producing one of the very essential elements of life, viz., cloth, should be in a situation where the country cannot absorb its total production. From the highest peak of about 6,23,000 bales of cloth in stock held by the mills, we have run down to 565,200 bales recently. But that is not due to larger or accelerated off-take of cloth but to the decrease in production. Twentyfive mills have already closed down and a larger number are working short in shifts.

The textile industry is suffering not only because of the excise duty. The excessive excise duties have of course primarily affected the working of the industry. It was not generally appreciated in New Delhi that there is a factor in economic life which is called consumer's resistance. We may go on putting excise duties and we may go on raising prices but consumer's resistance enters into the market at a certain stage where people refuse to buy a commodity beyond a certain price. The frequently altered excise duties are so high that they cannot be maintained. This creates an element of uncertainty in the markets. And, therefore, the wholesale dealer who in the past used to take the normal risk of carrying stock of cloth is naturally chary and hesitant about carrying normal stocks with the result that the industry is burdened with carrying on hand abnormally large stock of cloth.

Apart from excise duties, it has been realised by the industry itself that if this largest industry of the country is to be put on a permanently healthy footing, the pattern of production has to be changed and there has to be a lot of rationalisation in the working of the industry. Although it is true that certain units in the industry have been rationalised and modernised during the last five or seven years at very heavy cost, by and large the greater number of units in the industry are still anything but modern. These units are to be modernised. Unfortunately, we have not yet reached a stage where the local manufacturers of textile machinery can make available to the industry all the latest equipment that is necessary to modernise units. With the non-availability of foreign exchange and the consequent drastic cut in imports, both capital goods and essential requisites, the industry is not in a position today to modernise itself.

As a matter of fact, India woke up rather late in the day and did not realise that with such a large domestic market most of these accessories which are needed for our largest industry could have been made in this country long ago. It is, however, a very happy sign that a large number of these accessories are being manufactured in the country and made available to the industry today. One can well imagine the plight of the cotton textile industry if bobbins, spindles and various other accessories which we are making today were not indigenously produced. Under the very stringent foreign exchange situation, automatically a substantial part of the installed capacity of the industry would have been left idle without the supply of these essential accessories.

The genesis of the textile industry's present trouble lies in the political philosophy of our Government. When the "socialistic pattern of society" is put into actual action, we see how the established economy gets out of gear. It is high time to realise that this philosophy which may look a very fine horse in the stable becomes an arrant jade on actual journey.

I am a great believer in Free Enterprise. Every day, seeing what is happening in the country, makes me more confirmed in the view that the more of

(Continued on page T.6)

Preliminary Report on Service Uses of Cyanoethylated Cotton Products

By Jack Compton

Technical Director, Institute of Textile Technology, Charlottesville, Va.

(Continued from JOIE / June 1958–Vol. 2 No. 4)

V-Belt Cover Fabric. Cyanoethylated cotton chafer fabrics with nitrogen contents of 2.65 and 3.85%, along with cotton chafer fabric, were used as covers for V-belts and placed in accelerated service tests. Each test consisted of four belts each. The average time to failure of each series of belt covers was determined, Table XVI. The outstanding performance of cyanoethylated cotton chafer fabric with a nitrogen content of 3.85% will be noted although

TABLE XVI

Cyanoethylated Cotton Chafer Fabric in V-Belt Covers

Product	Belt cover failure, hr.*
Cotton	139
Azoton (2.65% N)	195
Azoton (3.85% N)	234

*Average of 4 test belts.

even with a nitrogen content of 2.65% greater life was experienced. It should be pointed out that an optimum nitrogen content for each fabric use may eventually be found, but in this preliminary survey it was necessary to limit the number investigated.

5. *Changed Electrical Properties*

Cyanoethylated cotton fabric (80 × 80 print cloth) has been found to have better insulating properties than cotton, Table XVII. The cotton and cyanoethylated cotton fabrics were tested under normal

TABLE XVII

Electrical Insulating Properties of Cyanoethylated Cotton Fabric

Fabric	Resistivity, ohms Room conditions 40° F.; 95% RH	
Cotton	9.1×10^{11} (W)	8.7×10^{6} (W)
	1.1×10^{19} (F)	8.1×10^{6} (F)
Azoton	1.1×10^{13} (W)*	6.5×10^{7} (W)
	1.1×10^{13} (F)**	4.7×10^{7} (F)

* (W) Warp 3.8% N.

** (F) Filling 3.1% N.

room conditions and at 95% RH and 140° F. for resistivity. The results from service tests indicate that the insulating and resistance to heat deterioration

(Continued from page T.5)

controls we have, the more of regulations we have, there is more throttling of individual initiative and enterprise and we are, therefore, unnecessarily retarding progress.

In an emergency like the one we are faced with today, when we are going to be short of imports of so many necessary articles and raw-materials, if individuals in the country had faith in the future of the country, in the sense that the utilization of their enterprise and initiative would merit the deserved reward that they should have, a lot could have been done to meet the emergency. I have not the slightest doubt that a country like ours which in the days of foreign regime, with nothing to encourage, was successful in building up industries which put India on the industrial map of the world and gave us the rank of the eighth industrial nation, does not lack talent, enterprise or initiative to fight an emergency of the present character. It is only a question of allowing people with initiative and enterprise to work and get the reward that they deserve as a result of their efforts. *(Courtesy: F. P. J. Bombay)*

properties are not, however, sufficiently better than cotton to warrant the added cost of production in some uses. In other uses this is not necessarily the case.

6. *Yarn Manufacture from Cyanoethylated Cotton Fiber*

In previous publications it has been pointed out that bulk cotton could be cyanoethylated successfully. In order to process cyanoethylated cotton fiber on the conventional cotton processing system, it is necessary to apply a softener in the last rinse water following cyanoethylation. A suitable softener has been found to be Ahcovel-F which is applied from a 2% solution based on the weight of the cyanoethylated cotton. An even better aid to processing this new fiber material is a mixture of 2% Ahcovel-F and 0.11% Ucon Oil HB2000 applied from a water dispersion based on the weight of the cyanoethylated cotton fiber. The softened cyanoethylated cotton fiber can be made into a picker lap using the finisher

TABLE XVIII

The Effect of 2% Ahcovel-F Softener with and without 0.11% Ucon Oil HB2000 on the Physical Properties of Azoton Cotton Yarn, 3.7% Nitrogen

Treatment	Yarn No.	Single end breaking strength Grams	Grams/Per cent grex	Elong.	%NU
Cotton	22.6/1	435	1.67	7.5	101.5
Azoton + Softener	21.4/1	378	1.37	5.3	177.5
	21.4/1	392	1.42	5.6	173.0
Azoton + Softener + Oil	23.2/1	330	1.30	5.7	140.8
	23.1/1	344	1.34	5.9	150.2

section of a picker, and is then carded to produce a 55-grain sliver. After two processes of drawing, it may then be processed into a 1.0 H. K. roving, and this roving into a nominal 22/1 yarn. The physical properties of the yarns produced in this manner, along with those of a cotton yarn of the same count, are shown in Table XVIII.

It will be noted the addition of the Ucon Oil to the Ahcovel-F softener caused a decrease in yarn strength but an improvement in yarn uniformity. In general the strength of the cyanoethylated cotton yarn with relation to cotton yarn is decreased in proportion to the number of fibers in the yarn cross sections. Since cyanoethylation to a nitrogen content of 3.7% increases the fiber weight by about 15%, the number of fibers in the yarn cross section will be decreased by this amount. Since the strength of the individual fibers is not changed by cyanoethylation, it should follow that the strength of the yarn should also decrease 15%, all other factors remaining the same. This in general has been found to be the case.

TABLE XIX

Azoton Market Survey

No.	Item	Report
1	Fish net and lines	Excellent, large demand
2	Marine ropes	No strength loss after 1 year. Test continuing.
3	Sand bags	Good after 2 years. Cotton deteriorated in 1 month.
4	Filter fabrics	Two to three times better than cotton where heat and acid are used.
5	Seed bed covers and Tobacco shade cloth	Good performance when in contact with ground or used on side walls as shade cloth.
6	Rugs	Firmer hand than cotton. Washed clean easier.
7	Abrasive fabrics	Excellent performance (three to four times better). Electroplating polishing, large market. Other users found it inferior to cotton.
8	Chafer fabric	Three to four times longer life in V-belt covers. In some other rubber items performance not good.

No.	Item	Report
9	Laundry press covers	Two to four times longer life than cotton. Most launderies prefer Dacron and nylon covers.
10	Twine	Sewing twine, excellent performance in tarpaulins.
11	Thread	Favored over Cu-8 treated cotton. No dermititis, sews well. Improvements in wearing apparel over cotton not sufficient to warrant change in most uses it is claimed.
12	Tarpaulins and awnings	Tests not complete. Good thus far. Demand for goods.
13	Insulating yarns	Good in tropics where mildew is a problem. Cannot compete with glass yarns and fabrics in high temperature motors.
14	Knit goods	No difficulty in knitting. Some unlevel dyeing encountered.
15	Sutures	Encouraging performance. Good knot strength.
16	Mops	Longer wear, faster absorption rate.
17	Corduroy	Difficulty in weaving and cutting. Softener application necessary. Prospects not too encouraging.
18	Reinforcing premolded rubber goods	Excellent performance.
19	Enamelling duck	Excellent, three to four times better than cotton.
20	Hose	Preliminary tests indicate use in forest fire hose.

Further work is needed on fiber finishes, and processing procedures before a high quality yarn can be produced from cyanoethylated cotton fiber.

Other Uses. Some of the other uses in which cyanoethylated cotton products have been evaluated are given in the Summary of the Market Evaluation Program along with some of the conclusions drawn, Table XIX.

COST OF CYANOETHYLATING COTTON

In the joint report issued by the Institute, American Cyanamid Company, and Monsanto Chemical Company detailed procedures are described for the cyanoethylation of cotton which can serve as the basis for large-scale development for both batch and continuous operations.

This plant, costing about $ 275,000 to $ 325,000 exclusive of building, steam, and warehouse would have an annual production of about 11 million lb. The batch process can best be carried out in package dyeing equipment in which cotton is treated in a single operation with acrylonitrile and caustic soda solution, whereas the continuous process consists of padding on caustic soda solution followed by contact with acrylonitrile vapor. Production costs by either method on fiber, yarn, or fabric is estimated to be 13 to 16 ¢ per pound.

CONCLUSION

Certain properties of cotton are changed by cyanoethylation so that improved performance in service uses, where rot and mildew, high temperature and acid conditions prevail, is realized. Other properties of cyanoethylated cotton differing from cotton that may prove of economic importance include: altered dyeing characteristics; lower moisture regain; increase in electrical insulation, flat abrasion resistance, and work required for rupture under tension.

End uses where these properties have been found useful include: fish nets and lines, marine rope and throngs, webbing, sand bags, tobacco shade cloth, seed bed covers, enamelling duck, acid filter cloth, sewing twine, sewing thread, tarpaulins, awning, electrical wire insulation for tropical use, chafer fabric for V-belt covers, buff wheel fabric, vulcanized fiber reinforcing, premolded rubber goods reinforcing, household ironing-board covers, special-use laundry press and roll covers and special fire hoses. Data

obtained in a market evaluation program on cyanoethylated cotton items has been presented for some of these.

The cost of producing cyanoethylated cotton fiber, yarn and fabric by either a batch or continuous process, as determined from pilot plant studies, is estimated to be 13 to 16 ¢ per pound.

ACKNOWLEDGMENT

The assistance of technical sales personnel of American Cyanamid Company and Monsanto Chemical Company in the field work of the cyanoethylated cotton market evaluation program is gratefully acknowledged. In particular, the names of Virgil Waggoner of Monsanto Chemical Company, C. L. Zimmerman, Gordon H. Kenyon and Dr. J. C. Pullman of American Cyanamid Company should be mentioned.

Members of the Institute staff participating in this work include T. L. W. Bailey, Jr., now with the United States Department of Agriculture, and Dr. L. H. Hance, who made significant contributions.

The interest and enthusiasm of the Institute Board of Trustees and Technical Advisory Committee and the sales organizations related to their respective mills, without whose help this program could not have been made, is also acknowledged with appreciation.

LITERATURE CITED

1. Bruson, H. A., "Cyanoethylation," *Organic Reactions*, Vol. V, edited by R. Adams, John Wiley & Sons, New York (1949).
2. Compton, Jack, Martin, W. H., Word, B. H., Jr., and Thompson, D. D., *Textile Inds. 117*, 138 A (1953).
3. Compton, Jack, *Am. Dyestuff Reptr. 43*, 103 (1954).
4. Compton, Jack, Martin, W. H., Word, B. H., Jr., and Barber, R. P., TEXTILE RESEARCH JOURNAL *25*, 58 (1955).
5. Compton, Jack, Martin, W. H., Word, B. H., Jr., and Barber, R. P., TEXTILE RESEARCH JOURNAL *26*, 47 (1956).
6. Compton, Jack, *The Furman Univ. Bull., Furman Studies 3*, 18 (1956).
7. "Cyanoethylation of Cotton," A Joint Report by Institute of Textile Technology, American Cyanamid Company, Monsanto Chemical Company (Sept. 1956).
8. Daul, G. C., Reinhardt, R. M., Reid, J. D., TEXTILE RESEARCH JOURNAL *25*, 246 (1955).
9. Fordemwalt, F., and Kourtz, R. E., TEXTILE RESEARCH JOURNAL *25*, 84 (1955).
10. Grant, J. H., Greathouse, L. H., Reid, J. D., and Weaver, J. W., TEXTILE RESEARCH JOURNAL *25*, 76 (1955).
11. Gruber, A. H., and Bikales, N. M., TEXTILE RESEARCH JOURNAL *26*, 67 (1956).
12. MacGregor, J. H., *J. Soc. Dyers Colourists 67*, 66 (1951); MacGregor, J. H., and Pugh, C., *ibid. 67*, 74 (1951).
13. National Cotton Council of America, Washington, D. C., Bulletin "Cotton Counts Its Customers," (Final Uses Revised 1953 Preliminary 1954) pp. 32 (1955).
14. von Brandt, Andres, *Archiv fur Fischereiwissenschaft. 6*, 381 (1956)

METAL TUBE PLANT IN INDIA

It is understood that a Bombay firm proposes to establish a factory for the production of non-ferrous metal tubes. The necessary licence has already been obtained, and negotiations are under way for the purchase of the main press and auxiliary machines for the extrusion plant.

Although the cost of the plant is estimated to be Rs. 12.50 lakhs, the company has been granted an import licence for only Rs. 4.5 lakhs. The promoters, Devidayal (Sales) Private Ltd., have, therefore, approached American and Indian financial institutions for loans to purchase machinery. The demand for non-ferrous tubes in the country is estimated at about 1,800 tons per annum and is expected to go up to 2,700 tons by 1961-62.

"TERYLENE" Plant of Canadian Industries Ltd.

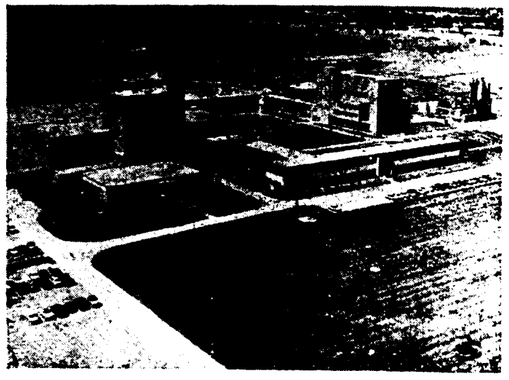
MILLHAVEN — ONTARIO

THREE years ago on the shore of Lake Ontario in central Canada, Canadian Industries Limited opened a multi-million dollar plant to produce "Terylene" polyester fibre. Already, this versatile product of the test-tube has won a well-established place for itself in textiles for clothing, home furnishings and industry.

"Terylene" was invented in 1941 by an English scientist, John R. Whinfield, who discovered how to make an excellent textile fibre starting with two products of the oil industry—terephthalic acid and ethylene glycol.

The new fibre proved to have a unique combination of properties: it is warm to the touch, remarkably resistant to stretching and creasing so that garments do not lose their shape, quick drying and seldom needs ironing. It is unshrinkable, highly resistant to abrasion, mothproof, and is exceptionally resistant to sunlight, especially behind glass.

The first yarn was made in England by Imperial Chemical Industries (the parent company of Canadian Industries Limited) in 1943 and "Terylene" was introduced to Canada when the C-I-L plant went into production in 1955.



An aerial view of the $22,000,000 "Terylene" plant of Canadian Industries Limited at Millhaven, Ontario. The plant, which took two years to build, stands on a 1,500-acre site on Lake Ontario. It produces polyester fibre for Canadian textile mills where it is converted into a wide variety of fabrics for men's and women's clothing and for many industrial end uses.

Fluffy "Terylene" staple fibre is tested for resilience in a laboratory at the "Terylene" plant of Canadian Industries Limited at Millhaven, Ontario. New fabrics require tailor-made fibres and tests such as this make sure they are suitable for the purpose for which they were designed.

In producing this talented fibre the ethylene glycol used is an extremely pure form of the "permanent" antifreeze used in car radiators and the other raw material, dimethyl terephthalate, is derived from terephthalic acid which is itself a petroleum-derived chemical.

Both these compounds must be chemically pure since impurities in either, to the extent of only a few parts per million, might weaken the catalysts used in the reaction process or might discolor the final fibre. The mixture is heated under reduced pressure and the reaction forms the "Terylene" polymer. At this point it is a tough, white resinous material which softens at 260 degrees Centigrade.

From this stage, through the remaining operations of its conversion to a finished product, the meterial undergoes no chemical change. The subsequent processes merely convert it from one physical form to another in order to impart the physical characteristics

which make "Terylene" so acceptable for a wide variety of end uses.

Apparatus called an "abrasion tester" in a laboratory of the "Terylene" plant of Canadian Industries Limited, at Millhaven, Ontario, subjects yarn to strenuous wear and helps predict how soon a hole will appear in children's slacks. Such research takes much of the guesswork out of producing good Canadian textiles.

Many different types of fabrics are possible because the fibre is produced in two forms: filament yarn which is a fine continuous thread like silk, and staple fibre, consisting of a mass of short curly fibres like wool. From these two forms of "Terylene" come an unlimited range of fabrics, from delicate sheers for women's dresses to tough gabardines for truck drivers' uniforms. The fibre can also be fluffed up into a soft resilient filling material called "fibrefill" for use in pillows, comforters, sleeping bags and quilted garments.

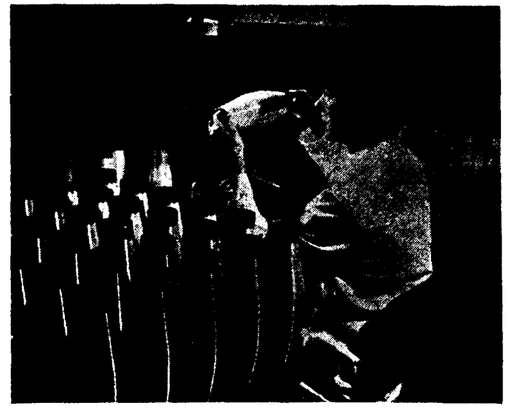
The advent of a new man-made fibre inevitably results in questions which can only be answered in a laboratory. To help fit the new fibre into Canadian fashion and industry, C-I-L invested about one million dollars in buildings and laboratory equipment for the technical department attached to the "Terylene" plant.

With the finest equipment available, the highly-trained staff of physicists, chemists, engineers and textile technicians in this department are performing three main functions: their first duty is to provide customers and potential customers with the necessary technical information and know-how to process "Terylene" filament yarn, staple and tow. Since the polyester fibre is still relatively new in Canada, the technical staff is devoting much time to the developing of technical data relating to proper handling methods covering all conversion processes from fibre to fabric.

The second important function of the laboratories is to develop new applications for this fibre which lends itself to a wide variety of uses both in the apparel and industrial fields.

The third function is to establish quality standards for the fibre produced in the plant. Technical personnel, because of their specialized knowledge and training, evaluate the fibre on textile equipment available in the laboratories and recommend the standards to which the fibre must be manufactured in order to establish and maintain a high reputation in the Canadian textile industry.

The modern field of textile blending has opened up possibilities for this fibre in Canada. When blended with wool, cotton or viscose, "Terylene" helps the garment keep its shape, hold pleats, shed wrinkles and wear a long time. However, good performance depends on the percentage of "Terylene" in the combination. With wool, it is recommended that at

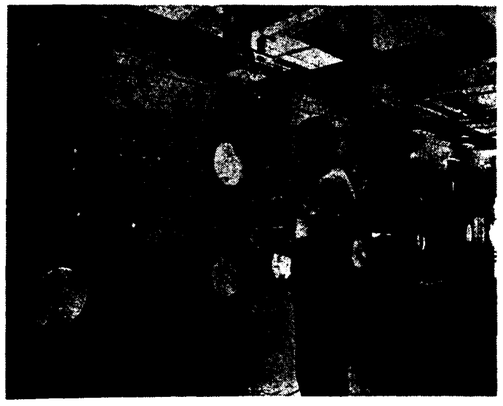


Silky bobbins of "Terylene" filament yarn which will be used in fabrics for dresses, shirts and lingerie, pass final inspection at the "Terylene" plant of Canadian Industries Limited at Millhaven, Ontario. Every step of the complicated manufacturing process is carefully watched to ensure high quality in this Canadian fibre.

least 50 per cent " Terylene " be used. With cotton or with viscose, 65 per cent " Terylene " is necessary.

A wide range of " Terylene " products are now on the market and C-I-L, with the co-operation of Canadian textile mills, is pursuing the development of new end uses for the fibre.

New fabrics containing " Terylene " used alone and in blends with wool, viscose or cotton are appearing every year. In the apparel field, the major emphasis at the present time is on developing a more complete range of " Terylene " and wool suiting fabrics in which medium weight checked and striped fabrics will supplement the presently available plain colored fabrics. In " Terylene "/cotton, the basic white blouse, shirt and dress fabrics are being extended by colored finer yarn fabrics and heavier weight blends suitable for nurses' uniforms, rainwear and sportswear.



At the " Terylene " plant of Canadian Industries Limited at Millhaven, Ontario, panels of electronic instruments keep a watchful eye on the complicated process involved in manufacturing this synthetic fibre.

In home furnishings, " Terylene " marquisette curtains and heavy boucle curtains in a wide range of colors and patterns are now being complemented by woven drapery fabrics of 100 per cent " Terylene " and of combinations of " Terylene " and viscose.

Progress is being made with uses of the fibre as an insulating material. Of particular interest is the recent development of heavy duty clothing and sleeping bags, which were successfully tested last winter by a Canadian meteorological expedition in the Arctic.

In the industrial field, the fibre's strength, dimensional stability and chemical resistance make it exceedingly valuable. It is being used with considerable success in paper machine felts, marine ropes and fishing nets, and is now being introduced in such applications as industrial belting and high pressure hoses.

Demand for " Terylene " has been steadily increasing year by year. Despite the general decline in business activity and competition from increased imports of textile products into Canada, domestic sales are holding up well. Increased world productive capacity of polyester fibre has reduced the export potential for Canadian-made " Terylene " but the wider range of fabrics now becoming available should res ult in increased domestic sales.

This versatile product of the test-tube is only three years old in Canada but in that short time it has become a well-established part of the country's textile industry. It will be playing an important role in years to come.

ALUMINIUM PLANT AT SALEM

It is proposed to construct a major aluminium plant with an output capacity of 10,000 tons per annum in Salem District, Madras State, where bauxite deposits as well as cheap power are available. Project reports are being completed by the French firm of Pechiney and the Italian firm of Montecatini who are both bidding for contracts. If the French get the contracts they are likely to collaborate with the National Industrial Development Corporation and the Plant will be run by the public sector. The Italians, who are already engaged in a survey of the bauxite deposits in the district, are negotiating with private interests in Madras. Possibilities of the latter getting the contract are bright, because, the Government of India are anxious to conserve their foreign exchange resources.

PAINTS, PLASTICS & CHEMICALS SECTION

The Role of Gas Turbines in the Future Chemical Industry

By Maurice M. Weiner

Product Planner,
Gas Turbine Department, General Electric Company,
Schenectady, N. Y.

1. INTRODUCTION

THE continual growth of the chemical industry over the years has incurred not only in an increased number of chemical plants but also in an increase in the size of these plants. Today's large plants, and tomorrow's even larger ones, have placed increased emphasis and importance on the varied utility requirements for the various processes. The magnitude and diversity of these utility requirements, such as electric power, heat for process, shaft power to drive pumps, compressors, etc., present a challenge to the prime mover industry. This challenge can and has been met by the gas turbine which is ideally suited to supply the stringent demands of the chemical industry for more economical plant operation.

2. HOW THE GAS TURBINE WORKS

In order to more fully understand how the gas turbine can be effectively integrated into the chemical processes, a brief description of the operating principles will be helpful. A General Electric 7000 HP simple-cycle, single-shaft gas turbine is shown in cross section in Figure 1. Atmospheric air is compressed to approximately six atmospheres in the 15 stage axial flow compressor. This compressed air passes into the combustion chamber where it is heated to the required turbine inlet temperature by the burning fuel. General Electric gas turbines are designed to operate on either natural gas, distillate oil, dual fuel, specification residual oil (Bunker " C "), or many low energy gaseous fuels. The resultant hot gases at 1400 to 1.00° F expand through the turbine developing the power to drive the compressor and the load. Exhaust temperatures from the simple-cycle machine are in the range of from 800 to 900°F, and the heat contained therein can be utilized in many ways. The speed range of the single-shaft

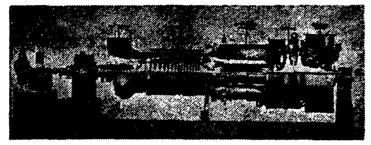


Fig. 1. Cross-section, 7000 HP Simple, Open-cycle Gas Turbine.

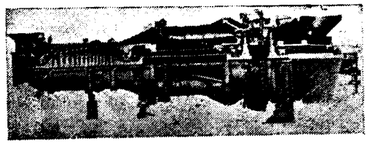


Fig. 2. Simple-cycle, Two-shaft Gas Turbine.

machine is adequate for many applications in the chemical industry, however, for applications that require a wider range of prime mover speed, a two-shaft gas turbine can be utilized. In a two-shaft unit, the high pressure turbine which drives the compressor and the low pressure turbine which drives the mechanical load are mounted on independent shafts assembled in one casing. A cross section of the two-shaft machine is illustrated in Figure 2.

The simplicity and extremely few wearing parts of this self-contained prime mover, as can be seen in Figures 1 and 2, provide the basis for the gas turbine's inherent reliability and low maintenance requirements.

3. GENERAL ELECTRIC OPERATING EXPERIENCE

The General Electric Company alone has shipped 127 gas turbines and has 75 units on order. These range in size from 5000 HP to 30,400 HP (3500 KW to 21,800 KW) and are utilized in the following applications :

Application	*Number of Units*	*Combined Capacity*
Locomotive	59	473,900 HP
Pipeline Pumping (Natural Gas)	63	361,600 HP
Power Generation	44	350,500 KW
Chemical	9	94,300 HP
Pipeline Pumping (Crude Oil)	13	91,000 HP
Oil Field Repressurizing	11	65,700 HP
Refinery	1	7,000 HP
Ship Propulsion	1	6,600 HP
U. S. Navy (Supercharged Boiler)	1	205,000 #/Hr. Air

The reliability of the gas turbine is now well established. As of the first of this year, our gas turbines had accumulated the equivalent of 170 continuous machine years of operation, or over 1½ million hours of service. The first combustion gas turbine-generator to be installed in the United States is located at the Belle Isle Station of the Oklahoma Gas and Electric Company. This unit has operated for more than 37,000 hours and has been run at more than 25 percent above its nameplate rating over the entire operating period. Our latest report indicates that this machine has experienced only two forced outages, for a total of 34 hours, in its first 34,000 hours of operation. Thirty hours of this forced outage time was accounted for by the failure of an oil pump impeller. This report also indicates that a second unit installed in the same plant has operated for roughly three years with no forced outages. The maintenance cost on the initial unit, as reported by Mr. J. W. Blake, Superintendent of the Oklahoma Gas and Electric Company, averaged $ 2.05 per installed kilowatt per year for the first 30,000 hours of operation. Included in this figure are some of the costs associated with the development of this first installation of a new type prime mover.

One of the largest gas turbine stations in the world is the Creole Petroleum Company's Lake Maracaibo, Venezuela installation. In this station, 10 General Electric 6000 HP simple-cycle, two-shaft gas turbines are mounted on a platform in the middle of Lake Maracaibo for the purpose of driving centrifugal compressors to repressurize an oil field located under the lake. In the first 13 months of service, the operating log for these 10 gas turbines indicates an availability of 98 percent for the gas turbines, and except for planned maintenance, the platform never had to be shut down due to a gas turbine outage. Figure 3 is a photograph of this station. The

Fig. 3. Ten G. E. Gas Turbines mounted on Creole Petroleum's pressure maintenance platform over Lake Maracaibo.

advantages of light-weight, compactness, reliability and low maintenance for an installation such as this can be readily appreciated.

Another large user of gas turbines is the gas pipeline industry. The El Paso Natural Gas Company alone operates 32 General Electric 5000 HP regenerative-cycle, two-shaft compressor drive machines for gas pipeline pumping. Based on the first year's operation of the first 28 of these gas turbines, Mr. T. H. Pofahl, Compressor Superintendent for the El Paso Natural Gas Company, reported that maintenance costs are expected to be on the order of 80 cents per installed horse-power per year. Availability of gas turbines in pipeline pumping service has been between 97 to 99 percent.

The foregoing figures all serve to indicate that the gas turbine's inherent reliability and low maintenance requirements are being realized in actual on-the-line service.

4. APPLICATIONS IN THE CHEMICAL INDUSTRY

Gas turbines are installed or on order for application in a variety of chemical processes throughout the country. These processes include butadiene, ethylene, nitric acid and many others. One of our first installations in the chemical industry was in the Baton Rouge plant of the Standard Oil Company of

Louisiana in 1953. In this ethylene process, a 5700 HP simple cycle, one-shaft gas turbine is used to drive three series process centrifugal compressors in tandem. The turbine exhaust discharges into an unfired exhaust heat boiler which generates low pressure process steam. The installation is shown in Figure 4. This unit has operated for 27,661 hours

Fig. 4. G. E. 5700 HP. Simple-cycle Single-shaft gas turbine driving compressors.

in the period from initial operation on November 17, 1953 to January 31, 1957 for a unit availability of approximately 98.5 percent. This figure includes all down time, regardless of the cause.

Because complete information is not available concerning the various processes in which gas turbines are operating, it appears that the potentialities of this prime mover can best be exemplified by indicating the services that the gas turbine has to offer and illustrating how these qualifications might possibly be utilized and integrated into the various chemical processes.

Figure 5 is a composite schematic diagram which illustrates the extreme versatility of the gas turbine.

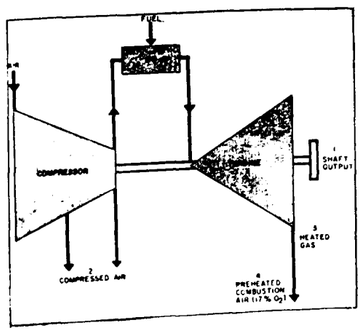


Fig. 5

In addition to shaft output, the machine can supply high pressure air, heated exhaust gas or preheated combustion air. Under the proper conditions, the combustion system can be eliminated, and the full air flow of the compressor can be directed to the process. This is illustrated in the simplified nitric acid process incorporating a gas turbine shown in Figure 6. Here, the full air flow of the turbine's

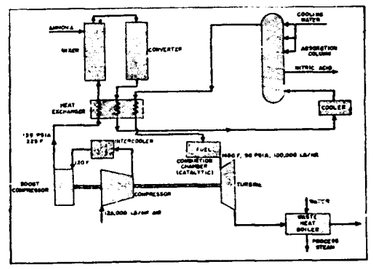


Fig. 6. Gas Turbines in Nitric Acid Process.

axial flow compressor is directed to the nitric acid process through an intercooler and turbine driven boost compressor. Waste gas from the acid absorption tower (roughly 80 percent of the original air) enters a catalytic combustion chamber where fuel is added to raise the temperature of the gas from approximately 900°F to 1450°F (this operation also reduces the NO and NO_2 in the waste gas to limit air pollution). This high temperature waste gas is expanded through the gas turbine which provides the shaft power to drive the axial flow and boost compressors. The exhaust gas from the turbine then flows through the exhaust heat boiler where process steam is generated.

A typical 7000 HP gas turbine can generate 40,000 pounds per hour of 150 psig saturated steam in an unfired exhaust heat boiler. Process requirements for greater steam flows can be satisfied by using a supplimentary fuel fired boiler. Under these conditions, the gas turbine exhaust can be used as highly preheated combustion air, as it contains roughly 80 percent of the oxygen available in standard air. When the exhaust of a 7000 HP gas turbine is utilized in this manner, it contains ample oxygen for a fuel fired boiler to generate over 300,000 pounds per hour of steam at a wide range of temperature and pressure.

Electric power generation can also be incorporated in this application by using a split flow, air extraction

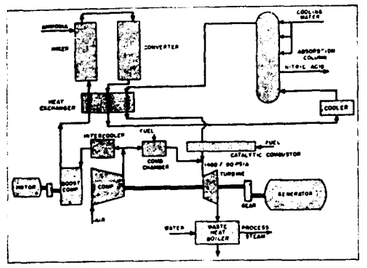


Fig. 7. Gas Turbines in Nitric Acid Process.

cycle as illustrated in Figure 7. This is similar to the previous nitric acid cycle except a larger compressor and a two-shaft turbine are used. The high pressure air flow is split at the compressor discharge. Part of the flow goes to the process through a motor-powered boost compressor, and the remainder enters a standard gas turbine combustion system. The products of combustion from the combustion chambers are then combined with the waste gas from the process before entering the turbine. The amount of power generation required would dictate the size of compressor and turbines used. The higher mass rate of flow in this system would considerably increase the process steam generating capability of the exhaust heat boiler.

The gas turbine can also be effectively applied in the dehydrogenation process for producing butadiene. Figure 8 indicates one method of using the turbine

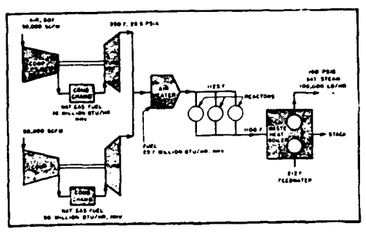


Fig. 8. Gas Turbines for Catalyst Regeneration.

exhaust gas as highly preheated, pressurized air for reactor catalyst regeneration. In this process, the catalytic reactors undergo a dehydrogenation period, a regeneration period and a steam purge period. A butadiene system utilizing seven reactors would have three reactors on regeneration at any given time. The regeneration of the catalyst consists of burning off built up carbon deposits and levelling the temperature of the catalyst bed. Steam for the catalyst purge can be supplied by the waste heat boiler. Although Figure 9 shows two back pressure gas turbines supplying the regeneration air, the same purpose may be accomplished with one large unit.

An alternate method of applying the gas turbine to the butadiene process is to direct the compressor air flow through an air heater to the reactors undergoing regeneration. The reactor exhaust gas, containing considerable excess oxygen, is brought up to the desired turbine inlet temperature in a combustion chamber before expanding through the turbine which drives both the compressor and the load. The load can either be a generator or one of the gas compressors required in the process. This cycle is illustrated in Figure 9.

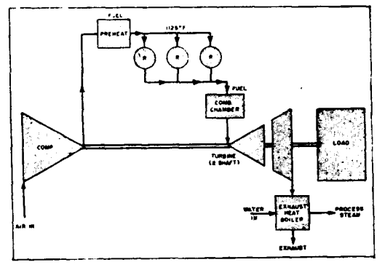


Fig. 9. Gas Turbines for Catalyst Regeneration.

Fluid catalytic cracking is another operation in which gas turbines can be gainfully employed. One form of applying gas turbines in this process is shown in Figure 10. One turbine drives a centrifugal

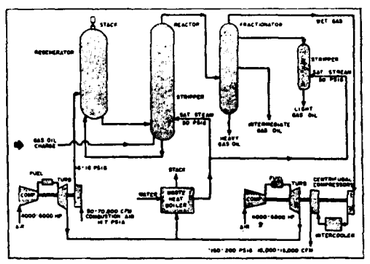


Fig. 10. Schematic Diagram of a Fluid Catalytic Cracking Process using Gas Turbines.

compressor supplying combustion air to the regenerator while another turbine drives two intercooled centrifugal compressors which pressurize the

wet gas from the fractionator. Both turbines exhaust to a common exhaust heat boiler supplying saturated steam for the system's stripping operation. A refinement of this cycle that would incur a significant increase in plant efficiency at a nominal cost increase would be to pass the hot process stack gas from the catalyst regenerator through a gas turbine regenerator (not shown). The gas turbine regenerator is basically a heat exchanger in which exhaust energy in the form of heat is transferred to the high pressure turbine combustion air between the compressor discharge and the combustion chamber inlet. For a given machine, this will require that less fuel be burned in the combustors for a given turbine inlet temperature, thereby increasing the overall thermal efficiency of the unit.

The production of ethylene requires a large amount of shaft horse-power in the form of process compressor drive. Figure 11 indicates the utilization of a gas turbine to efficiently supply this power. The

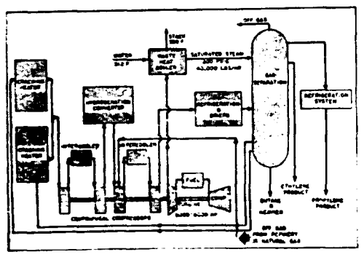


Fig. 11. Simplified Ethylene Plant Incorporating Gas Turbine

turbine in this very simplified version of an ethylene plant drives four series flow centrifugal compressors in tandem and exhausts through an unfired boiler to supply steam for the process. Other compressor drive requirements in the refrigeration cycle can also be adequately supplied by a gas turbine.

Many chemical processes, such as the ethylene process mentioned above, give off substantial volumes of low or intermediate energy combustible gas. Many of these gases constitute excellent gas turbine fuels. Where the off-gas is available at high pressures, on the order of 150 psig, it is feasible to start the gas turbine on natural gas or oil fuel and switch over to process off-gas fuel when it becomes available. Where the volume of off-gas is not sufficient to meet the full fuel requirements of the gas turbine, it can be used as a supplementary fuel and burned in combination with natural gas or with oil in a dual-fuel machine. General Electric dual fuel burning gas turbines are presently in operation and exhibit excellent performance. A system operated in this manner can be made partially, or completely self-sustaining. When the process off-gas is available at pressures lower than 150 psig, it will in general be necessary to install a suitable gas compressor and required accessories capable of increasing the off-gas pressure to the required turbine combustion system level.

In many chemical processes, a large quantity of process steam is required and must be available at all times. It is possible to utilize some of this steam in the gas turbine to supply increased power that may be required for the peak power demands of the system. In this application, the gas turbine's rated output is determined by the normal power requirements of the plant. During periods of power demands in excess of normal requirements, steam is injected into the gas turbine combustion system from the exhaust heat boiler. This can be accomplished with a simple manual control and a metering orifice, or semi-automatic control if desired. The gas turbine cycle is shown schematically in Figure 12. By

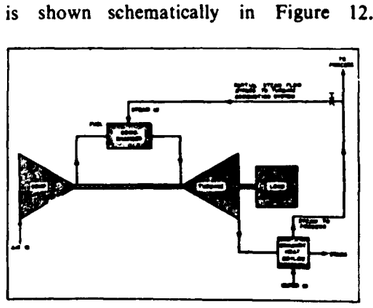


Fig. 12. Steam Injection Cycle.

injecting steam in this manner, it is possible to increase the output of the gas turbine by roughly 40 percent more than the 80°F rating with the induction of 10 percent steam. (The 10 percent steam refers to a mass ratio of steam to turbine exhaust gas flow.)

Production of chlorine by electrolysis accounts for the major amount of this chemical's manufacture. This method of production utilizes large quantities of d-c power and steam. Figure 13 shows one system of applying gas turbines in conjunction with a steam turbine to economically supply these requirements. In this application, three 4500 KW gas turbine-generator sets are used to generate 13,500 KW of d-c power and supply heat to the three dual exhaust

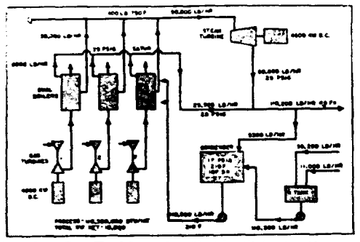


Fig. 13. Gas Turbines Applied in Chlorine Process.

heat boilers. The three dual boilers generate 25,500 pounds per hour of 25 psig saturated steam for process and 90,000 pounds per hour of 400 psig, 750°F steam for the steam turbine working fluid. After expanding through the steam turbine-generator and producing another 4500 KW of d-c power, this steam flow is also directed to the process. In total, this arrangement nets 18,000 KW of d-c power and 110,200 pounds per hour of process steam.

The illustrations shown above are but a few of the almost limitless possibilities in which the versatility of the gas turbine can be profitably employed by the process engineer. Studies show that the gas turbine can also be effectively integrated in the acetylene, ethylene oxide, methanol, tonnage oxygen, coal hydrogenation and many other processes. Although the major emphasis here has been on integrated process applications, the coming years should also see a large amount of the extensive electric power requirements of the chemical industry supplied by gas turbine-generator sets.

NEW HEATING ELEMENT

Power - Conducting Glass Fabric

Normally, electric heating elements are constructed with resistance wire and their application is confined to the production of heat for use by radiation from a glowing element.

A problem arises however when there is need to spread the heat which has been generated, and a method of transferring the heat becomes necessary.

This can be done by direct radiation as in the case of a fire, by induced air currents as in convertors, by fan-produced air currents, or transfer media such as oil and water. All these methods have the one common drawback in that there is a loss of heating efficiency to a varying extent.

Now there is a new product, Mhoglas, made by Hunting Mhoglas Ltd., of Luton, England, which it is claimed overcomes this efficiency loss and offers exactly the advantage which wire heaters lack.

The material is made by a process which make glass fabric electrically conducting. This is because, as the element itself is in sheet form, the whole of which heats evenly, the heat generated is also in sheet form.

Among the wide varieties of use to which Mhoglas may be put are heated panels, skirting boards, floors, tables and walls. It has also been used in tests with great success in solving aircraft de-icing problems, and in the plastics industry.

One important claim for the new material is that it cannot cause a burn if touched, a great safety point in any form of panel heating. The normal running temperature is that of hot, though not boiling water.

TISCO WORKERS' BONUS—

Over Rs. 1 Crore To Be Paid

The authorities of the Tata Iron and Steel Co. announced that they had agreed to pay Rs. 1,08,15,000 as profit-sharing bonus to their employees this year, which is Rs. 1.4 lakhs higher than the sum paid last year.

For the past several years the profit-sharing bonus has been determined by a formula agreed to between the management and the Tata Workers' Union. That agreement expired last year. "Had that agreement been in force, the bonus payable this year would have been only Rs. 83 lakhs, the management stated.

Last year, each employee received 2.68 months' basic wages as the year's profit-sharing bonus. It is expected that the disbursement this year will be approximately at the same level.

A similar announcement was made by Mr. Michael John, President of the Tata Workers' Union, at a mass meeting.

RESTRICTED GATING

From Our Overseas Correspondent

NON-RIGID vinyl molding compounds can be readily injection molded into pieces having the overall high quality surface appearance necessary to meet the critical demands of engineers and designers. The improved restricted gating system perfected by UNION CARBIDE and the use of proper molding conditions make possible the molding of pieces essentially free from flow lines, splash marks, and other surface defects.

By the use of proper restrictions, the effective thermal plasticization of vinyl elastomers is accomplished without using excessively high cylinder temperatures normally injurious to vinyl compounds. The restriction results in instantaneous frictional heating of the material just prior to its entry into the mold cavity; this ensures high gloss and a uniform surface appearance.

Experience with double restricted gating has indicated further advantages for the injection molding of vinyl elastomers under even the most difficult conditions.

GENERAL OBSERVATIONS

The salient features regarding the use of the restricted gating method, its application, and its advantages have been summarized and are listed below:

1. Surface appearance and visual qualities of the molded product are greatly improved by the resulting high gloss, relative freedom from flow lines and splash marks, and the minimizing of surface blemishes that might be caused by insufficient color dispersion.

2. Lower cylinder temperatures are possible with restricted gating. For example, in a particular application employing a 60 durometer compound (VND–9960), high gloss was consistently obtained with a cylinder temperature of 260 deg. F. (127 deg. C.) When a larger conventional gate was used, a cylinder temperature of 360 deg. F. (182 deg. C.) was required to attain equal gloss; however, after a few minutes, this resulted in discoloration and surface defects due to decomposition.

3. With proper design and operating conditions, no discoloration or material degradation is apparent with the use of lower cylinder temperatures and "flash heating" of the material as it is forced through the gate under high pressure. However, excessively small gates may result in too much heating and consequent material decomposition leading to splash marks or blisters.

4. When dry-colored material is used, significantly improved color dispersion, occurring as the molding compound is forced through the restriction, represents another means of improving the surface qualities of a finished product. In effect the use of a restricted gating system means that the molten vinyl material is briefly but thoroughly mixed as it travels through the small orifice.

5. Higher injection pressures are required when the restricted gating system is used. For example, an increase from 7000 psi to 15,000 psi (492 to 1055 kg./cm.^{2}) was required for a standard 80 durometer vinyl molding compound (VND—9980) when the operation was converted from conventional gating to restricted gating.

6. Dimensions are critical for the restriction and location of the pin, and the optimum size of restriction varies somewhat from mold to mold. In most cases, the restriction should be in the range 0.015—0.025 in. (.4 – .65 mm.) diam. with 0.040 - 0.060 in. (1.0 - 1.5 mm.) land, but occasionally dimensions outside of this range are required. It is suggested that the restriction be made initially 0.015 in. (.4 mm.) diam. by 0.060 in. (1.5 mm.) long and altered as required. Overall high gloss with the presence of small blisters usually indicates that the diameter of the restriction should be increased gradually until blisters are eliminated. If excessive pressure is required to fill the mold, the land length should be reduced rather than the diameter increased. The end of the runner should be abruptly rounded (as by means of the radius end mill used in cutting the runner) rather than gradually tapered into the restriction.

7. A triangular shaped pin, placed 0.100 in.

(2.54 mm.) from the restriction and 3/4 in. (19.0 mm.) from the cavity, is recommended. After considerable experimentation with various pin designs, it was found that the triangular pin placed with a flat side perpendicular to the restriction opening and its apex directed toward the cavity opening was most efficient. It serves as an impinging plate for the thread-like stream of material spurting from the restriction and further eliminates the possibility of flow or weld line formation at this point.

8. The term "gate" should refer not only to the immediate entrance fo the mold cavity but should also include the restriction and area surrounding the pin.

9. The actual entrance to the cavity should be about 0.010 in. (.25 mm.) less than the thickness of the molded piece at the point of entry, and should be flush with one face of the molding. This procedure has served to eliminate minor surface blemishes on the molded piece.

10. The design and placement of the cavity entrance must be studied with respect to the contours of the mold interior. The flow of the material is vitally important to the good appearance of a finished product. In general, the gate should be located with the objective of: (1) Minimizing the distance the material must flow; (2) keeping the gate as close as possible to core pins and other obstructions around which the material must flow and weld; (3) keeping the gate in an inconspicuous location; and (4) keeping possible weld lines (resulting from flow around core pins, etc.) in inconspicuous spots.

11. Double restricted gating may be employed for extremely difficult cases of poor surface appearance, such as may occur with unusually large pieces or long runner systems. Here, the first restriction is placed as described above, and the second restriction is placed in the runner at or near the sprue bushing. The second restriction is usually 0.030 in. (.76 mm.) diameter by 0.060 in. (1.5 mm.) long. In effect, this duplication of restriction produces two points of flash heating, thus providing additional heat without material degradation.

12. Actual field applications have provided proof of the validity and usefulness of the restricted gating and double restricted gating systems. Details of various field applications are presented at the end of this discussion.

The early injection molding of vinyl elastomeric compounds was seriously limited by the high viscosity of the material at allowable operating temperatures. This was particularly true of the higher durometer compounds. In considering the heating of vinyl elastomers (or any other thermoplastics) in injection molding, the time of travel through the cylinder and the cylinder temperature at all points in the cylinder and nozzle must be taken into account. In addition, it must be recognized that there is a loss of heat by the material during passage through the normally cold sprue and runners.

These factors determine material temperature and fluidity at the time of delivery to the mold cavity which, in turn, is a major factor in determining the appearance of the finished molded piece. For best appearance, the material should be as hot and as fluid as possible when it enters the mold cavity. Because of the thermal sensitivity of these vinyl compounds, however, the technique of simply increasing cylinder temperature, used successfully with some other thermoplastics, is not applicable.

At least two approaches to the problem of increasing temperature and fluidity are available; namely, formulation and molding technique. Considerable success has been encountered in the first approach with the use of UNION CARBIDE Brand Vinyl molding materials, having excellent thermal stability. The concern in this report, however, is with the second approach, which deals primarily with the mechanical aspects of the molding problem.

TEMPERATURE LIMITS

With the present stabilization of UNION CARBIDE vinyl elastomeric compounds, a material temperature limit of about 350 deg. F. (177 deg. C.) is imposed at the nozzle. Travel through sprue and runners has a cooling effect so that material delivered to the cavity is somewhat below the temperature at the nozzle. For some shapes, and particularly with 80 and 90 durometer compounds, this is not sufficient to produce acceptable pieces of uniformly high gloss. In such cases, noticeable improvement can often be made by increasing the cylinder temperature, but this is only of academic interest since material discoloration occurs after a short time.

Formerly, it was customary to employ large gates of

1/8 in. (3.2 mm.) diameter or more, very often of the same size as the runner. Such gates, naturally, contributed nothing toward increasing material temperature. Experimentation and broad field experience during the past few years have shown that the use of a restriction at or near the cavity entrance, coupled with the use of higher pressure, has a great effect on improving gloss. This is because the work done in forcing the material through the restriction results in frictional heating with an almost instantaneous temperature rise that is sufficient to give the desired high gloss but is too brief in time to cause discoloration or decomposition.

Thus, heating of the material can be looked upon as a two-step process. The cylinder constitutes the first step. Here the material should be heated to a level where the possibility of discoloration is remote but where fluidity is sufficient for machine operation. The second step is at the restriction where a final "flash" heat is obtained frictionally.

LABORATORY STUDIES

Elementary considerations of good mold design used in the work described below were:

1. Use of full round runners.
2. Blunting (no streamlining) of the runner before the restriction to permit only the hot center material to flow through the restriction and not the chilled layer of material adjacent to the runner wall.

The first laboratory study at UNION CARBIDE in applying restricted gating to a mold was performed in a two-cavity knob mold. A sketch of this mold with

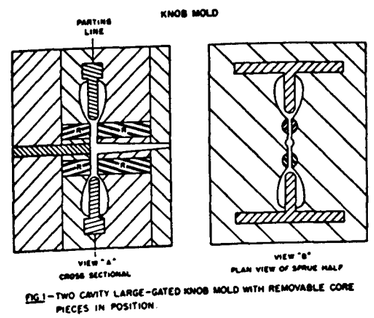


FIG. 1 — TWO CAVITY LARGE-GATED KNOB MOLD WITH REMOVABLE CORE PIECES IN POSITION.

the large gate in existence at that time and with core pieces in position is shown in Fig. 1. View "A" is a cross-sectional view of the mold, while "B" is a plan view of the sprue half. The knob is a hollow piece approximately two inches (5 cm.) long with an I. D. of 1/2 in. (1.3 cm.) and an O. D. of one inch (2.5 cm.) at the widest point. Wall thickness is dependent upon the dimensions of the core piece. At the start of this work, the smooth insert ("Original") and the threaded insert shown in Fig. 2 were in use.

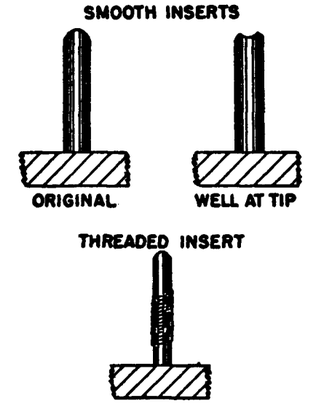


FIG. 2 — THREE TYPES OF INSERTS USED IN RESTRICTED GATING STUDIES.

The mold was adaptable to a study of the effect of gating since both gates were in removable pins ("R" in View A, Fig. 1) and gate changes were made by making new sets of pins. These pins were also runner stops; by rotating the pins the cavities could be closed of independently.

The new runner stop pins were based on the four different gating systems shown in Fig. 3 (mold surface

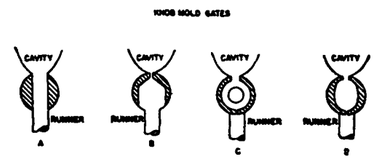


FIG. 3 — OF FOUR GATING SYSTEMS TRIED, C AND D PRODUCED THE BEST RESULTS.

views). Systems A was the type used at the beginning of this program. Runner and cavity entrance were both approximately 1/4 in. (6.4 mm.) full round. This

system had never given pieces of uniformly high gloss except with the soft 60 durometer compound, and there only with the smooth insert. Normally, molded pieces had dull areas on the surface.

System B consisted of a 3/8 in. (9.6 mm.) full round runner tapering sharply over a 3/32 in. (2.4 mm.) distance to a 0.015 in. (.4 mm.) full round cavity entrance 1/16 in. (1.6 mm.) long. With the smooth insert, this system produced pieces of good overall gloss but with severe "splash" marks and weld lines resulting from poor knitting of the thread of material jetting through the 0.015 in. (.4 mm.) diameter gate. This particular insert provided a space of about 0.100 in. (2.5 mm.) in the mold cavity between the tip of the insert and the gate, and the effect of reducing this distance was investigated. Use of a longer core piece, which brought the tip of the insert to within 0.20 in. (5.0 mm.) of the gate, reduced the splash marks considerably. However, perfect pieces over the normal hardness range of 50 to 90 durometer were not obtained with this system of gating, even though gate dimensions were varied. Results with the threaded insert were somewhat poorer.

System C was more successful. Here the restriction was moved back from the cavity, a pin was introduced in front of the restriction to produce annular flow, and a large entrance was used directly into the cavity. Satisfactory dimensions for the restriction were 0.015 in. (0.4 mm.) diameter and 1/16 in. (1.6 mm.) length, a 3/16 in. (4.8 mm.) round pin, and a 1/8 in. (3.2 mm.) round cavity entrance. The grooves around the pin were 1/8 in. (3.2 mm.) full round runners. Pieces of good gloss and acceptable appearance were produced using both smooth and threaded inserts, but the 3/16 in. (4.8 mm.) dowel pin produced a streaming weld which was not eliminated by going through the 1/8 in. (3.2 mm.) cavity entrance.

Continued experimentation with this system has shown that a triangular pin rather than the round pin is preferable and that the pin should be placed 0.100 in. (2.5 mm.) from the restriction and preferable 3.4 in. (19.0 mm.) from the cavity. Originally with the round pin, it was found that the molten vinyl material streaming from the restriction tended to skim the preimeter of the pin and to flow directly into the cavity. This ultimately caused weld lines on the surface of the finished product. The incorporation of a triangular shaped pin placed with a flat side perpendicular to restriction opening eliminated this shortcoming. Acting as a baffle plate, the flat side of the pin caused the impinging stream of material to "ball-up" and flow around the edges of the pin, through the cavity entrance, and into the cavity as a homogeneous mass.

System D without the pin and with the restriction increased to 0.020 in. (0.6 mm.) diameter and cavity entrance reduced to 0.040 in. (1.0 mm.) diameter, also proved successful when used in conjunction with the insert having a well at the tip (Fig. 2). The well assisted in "balling up" the first material issuing from the gate.

Subsequent work has shown that this gating system is limited to small parts in which the gate is so located that the material entering impinges on a flat or hollow surface. Land lengths in both restriction and cavity entrance should usually be in the range 0.040—0.060 inches (1.0—1.5 mm.).

COLOR CHECKERS

The experience gained with the laboratory knob mold was next applied to the production of color checkers to be used for sales purposes. This was a particularly difficult job because the color checkers had to be perfect on all surfaces. Commercially, there is often some place at which blemishes can be hidden where they are not visible to the user. A six-cavity mold with the conventional large-size gating had been built and after some initial difficulties was being operated satisfactorily for production of polystyrene and polyethylene color checkers. However, satisfactory color checkers with a uniformly high gloss could not be molded from vinyl elastomeric compounds.

The color checker itself contains four steps of different thicknesses—0.050, 0.100, 0.150 and 0.200 inch (1.2, 2.5, 3.7 and 5.0 mm.). The length is 2-7/16 in. (6.2 cm) with the width tapering from 1-3/4 in. (4.4 cm.) at the thick end to 1-1/2 in. (3.7 cm.) at the thin end. The mold parting line is on the center line of the piece edge. The tapered sections between the steps are at a 45 deg. angle.

A two-cavity color checker mold was designed and built to explore the application of restricted gating to this problem. The mold had been designed before the work on the laboratory knob mold was complete and the cavities were gated directly into the thin section with a restricted gate as shown in Fig. 4 (A).

The designated gate was 0.015 in. (0.4 mm.) in diameter and 1/16 in. (3.2 mm.) long and entered the cavity from a 1/4 in. (6.4 mm.) full round runner into the side of the thinnest section. The difficulties

encountered with this system are shown in Fig. 4. For one thing, the injected plastic flowed only one-half to two-thirds of the way across the cavity from the gate and then filled out the thicker sections, circling around to the corner opposite the gate and filling that last. This caused a prominent weld line as shown in Fig. 4(A). There were also smear marks and a slight distortion around the gate. Weld lines at the steps indicated that the plastic had jumped over and then folded back to fill the void. The over-all gloss was good, showing that the restricted gate was doing its job of heating the material sufficiently.

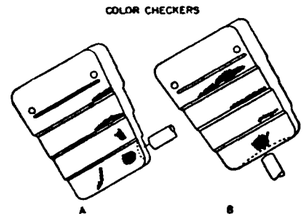


FIG. 4 — RESTRICTED GATING DIRECTLY INTO THIN SECTION CAUSED WELD LINES AND SMEAR MARKS.

These defects could not be remedied by changing molding conditions or gate size, and a similar gate was next tried at another point on the thin section as shown in Fig. 4 (B). This cured the prominent weld line in the thin section, but the weld lines due to jumping over at the steps were somewhat worse and distortion or pushing in at the gate was definitely worse.

The problem of jumping over at the steps seemed inherent in entering the cavity from the thin end and the next step was to try gating from the thick end. Preliminary trials with a restricted gate directly into the cavity again gave an overall high gloss and did not show the jumping over at the steps, but did give numerous weld lines. The first material issuing from the restricted gate jetted into the large open cavity and cooled in the form of a " ball of yarn " which did not weld properly when the cavity filled. This " ball of yarn " is readily visible in a short shot. Therefore, the technique used in the knob mold of moving the restriction back into the runner and entering the cavity with a large opening was tried. The first two systems used are shown in Fig. 5.

Here again the restriction was 0.015 by 1/16 in. (0.4 by 1.6 mm.) and placed 3/4 in. (1.9 cm.) from the cavity entrance to coincide with a right angle bend in the runner. The runner was 1/4 in. (6.4 mm.) full round as before and the cavity entrance was rectangular—0.200 by 0.250 inch (5.0 by 6.3 mm.). Gating shown in Fig. 5 was tried first. This was immediately

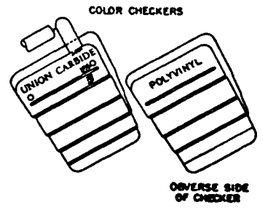


FIG. 5 — RESTRICTION IN RUNNER, LARGE OPENING INTO CAVITY, RESULTED IN POORLY MOLDED LETTERS.

successful in giving good pieces except for difficulties caused by the lettering, which was recessed in the mold cavity on both sides. The " E " of CARBIDE directly in front of the gate caused a smeared area as shown. There was no letter in front of the gate on the reverse side (POLYVINYL) because of the smaller size lettering employed there, and consequently, no smear mark. There were small curlicues around the letters on both sides which varied in position and severity from piece to piece. The " E " was the cause of the smearing and this was conclusively shown by the fact that when the " E " was soldered smooth, the smearing disappeared.

The next step taken was to enter the thick section of the piece from the side as shown in Fig. 6. Again

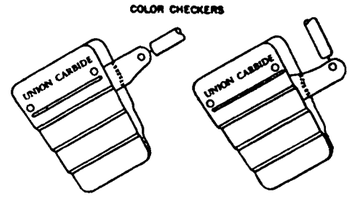


FIG. 6 — PERFECT PIECES WERE MADE BY ENTERING THICK SECTION FROM SIDE WITH GATING SHOWN

the restriction was 0.015 by 1/16 in. (0.4 by 1.6 mm.) and located 3/4 in. (19 mm.) back in the runner from the cavity. This eliminated imperfections around the letters associated with the previous gates. After a number of trials, the two gates shown in Fig. 6 were worked out dimensionally to give nearly perfect pieces. Both cavity entrances are 1/2 in. (13 mm.) wide and approximately the thickness of the cavity at that point. In both cases, it was necessary to overlap into the adjacent section to eliminate a small smear at that point. A 1/8 in. (3.2 mm.) pin located 0.100 in.

(2.5 mm.) from the restriction helped in both cases in eliminating the last traces of weld lines. This had been tried with the gates in Fig. 5 without success. A final difficulty was encountered with a shiny spot, appearing on one side or the other of the piece, when either cavity entrance (Fig. 6) was made flush with the cavity on both sides. When the entrance was stepped down 0.010 to 0.012 in. (0.25 to 0.27 mm.) on one side (dotted lines in Fig. 6) this disappeared. However, when the entrance was stepped down on both sides, flow marks appeared.

This study demonstrated, as did the work with the knob mold, that the use of a 0.015 by 1/16 in. (0.4 by 1.6 mm.) restriction at the gate or in the runner near the gate developes high gloss with vinyl elastomeric compounds at molding temperatures well below the danger zone for this material. However, as in all mold design work, the production of unblemished pieces is dependent on gate locations and dimensions. In cases where adjustments of dimensions must be made to meet specific problems, care should be taken to use small increments in decreasing or increasing the size of the restriction. As an example, an increase in the restriction diameter from 0.010 in. to 0.020 in. (0.25 to 0.5 mm.) represents a 400 per cent increase in the cross-sectional area of the restriction. In most instances, an enlargement of this magnitude would be out of proportion.

DOUBLE RESTRICTED GATING

In the practical application of the restricted gating molding method, it was found that for unusually large or complicated pieces a single restriction did not entirely compensate for the lower and safer cylinder temperatures. Further laboratory study by UNION CARBIDE indicated the use of the second restriction as a desirable and feasible means of overcoming difficulties in such extraordinary cases. Essentially, this means the placement of a restriction farther back in the runner, preferably at or near the sprue bushing. The restriction, itself, would be designed with a diameter of 0.030 in. (0.75 mm.) full round and a length of 0.060 inch (1.5 mm). Here, dimensions are critical just as they are for restrictions at the cavity. The additional advantage of a second rapid frictional heating is gained as the material is forced through the second restriction. In cases where the molder has introduced the double restricted gating system, the finished product exhibits a smooth, glossy appearance practically free of weld lines, flow lines, and surface blemishes.

FIELD APPLICATION

One of the early opportunities to apply laboratory experience on restricted gating to a commercial molding job was offered when an injunction molder undertook the production of vacuum cleaner handles. Sketches of the part are shown in Fig. 7. The handle is approximately 8-1/2 in. (21.5 cm.) long by 1-1/8 in. (2.9 cm.) wide. Thickness varies from approximately 5/32 to 7/16 inch (4 to 11.2 mm.) Weight is 1-3/4 oz. (40 gms.).

A four-cavity mold had been designed and built but the molder was not able to produce satisfactory pieces. A 90 durometer compound had been specified. Normal mold design practice had been followed and each cavity supplied by a 1/4 in. (6.4 mm.) full round

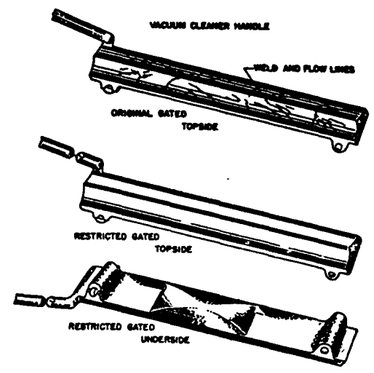


FIG. 7 — RESTRICTED GATING (CENTER AND BOTTOM DRAWINGS) IMPROVED QUALITY OF MOLDED PIECES.

runner and a 1/8 by 1/4 in. (3.2 by 6.4 mm.) gate at one corner as shown in Fig. 7 (top). The handles produced in this mold were low in gloss with numerous surface imperfections. Use of the highest possible cylinder temperatures without material decomposition gave unsatisfactory pieces.

A restricted gating system similar to the one successfully used in the color checker mold was recommended and its trial immediately gave beneficial results. The improvement in appearance was very striking and the molder has since molded this item successfully on a production basis. The molded handles are of very high gloss and essentially free of surface blemishes.

The gating system used is shown in the sketch of the four-cavity mold in Fig. 8. The cavity entrances and runner positions are essentially unchanged from the

(Continued on page P.16)

DU PONT'S New Developments & Products for Industries

From A Technical Correspondent

HALF-MILLION 1957 AMERICAN AUTOMOBILES FINISHED IN NEW "LUCITE" ACRYLIC LACQUER

IN 1957, well over half a million American automobiles were finished in Du Pont's new "Lucite" acrylic lacquer, and current indications are that in 1958 this figure will be exceeded by a significant margin.

In a recent speech before the National Automobile Dealers' Association, Roy B. Davis, assistant director of sales of the Du Pont Company's Finishes Division, told of the success of the recently developed automotive finish and its growing use in the United States and in other automobile manufacturing countries.

Before "Lucite" was announced as a finish which would make new car waxing unnecessary for 18 months, a long period of research and testing was carried out. These tests were first made by researchers in Du Pont laboratories and then by automobile manufacturers. To gain approval the new lacquer was required to give satisfactory performance on 47 points. Among these were high gloss retention for long periods without waxing, durability, and resistance to corrosion and to weathering. In general, it had to demonstrate its ability to impart long-lived, new car beauty through years of service before it was made available to owners of new cars.

Mr. Davis gave a brief summary of Du Pont's years of research in the field of automotive finishing, marked in 1924 by the development of rapid-drying "Duco" nitrocellulose lacquer. With "Duco", time required to finish new automobiles was reduced from weeks to hours, and weather ceased to be a vital factor in the finishing process. Later, in 1930, "Dulux" synthetic high-gloss enamel was developed for manufacturers who preferred a baked enamel finish.

Then in 1955, "Lucite" acrylic lacquer was announced. Its durability high gloss, and the fastness of its bright colors indicated it would be a welcome addition to the Du Pont line of automotive finishes. Its rapid acceptance in 1957 has justified early expectations.

Research has continued, and now Du Pont has announced several new products to simplify spot repair, refinishing, and over-all finishing. These new products, to be used by professionals, mean that auto owners throughout the world may acquire the long-lasting beauty of "Lucite", whether or not their automobiles were finished at the factory in this unique automotive lacquer.

NEOPRENE GASKETS SEAL GLASS WALLS AT NEW YORK AIRPORT

A new method of sealing panels in the construction of glass exterior walls is being used on New York City's gigantic International Airport Arrivals Building. The new system eliminates caulking and permits streamlined installation that cuts cost drastically.

The Idlewild Arrivals Building, one of the largest single applications of glass in the history of the construction industry, is completely enclosed with thousands of glass panels of various kinds and sizes. The building, scheduled for completion this fall, is a three-story structure, 1,760 feet long and 415 feet wide, with two wings two stories in height, each 240 feet long.

To provide economical, trouble free installation, a special neoprene gasket was developed by the architects, Skidmore, Owings and Merrill, in cooperation with the Du Pont Company, Pawling Rubber Corporation, and several glass companies. It was adopted after extensive testing at the laboratories of the General Bronze Company on Long Island, New York. The gasket, prefabricated to the architect's specifications in the Pawling plant, arrives at the construction site as a unit and is easily snapped around the pane by one workman. A movable stop applies pressure to the gasket, providing a uniform, permanent seal between glass and frame.

The resiliency of neoprene allows the glass to yield within the gasket under wind pressure and to expand and contract with changes in temperature. This resiliency greatly reduces danger of breakage and was an important consideration in the selection of gasketing material. If, however, a panel should be broken, the prefabricated assembly may be re-used in replacing it.

It is expected that in other large buildings now on architects' drawing boards, neoprene gaskets to hold glass panels in place will also be used, since in addition to their practical value as efficient sealers, their cost in the completed structure is about half that of conventional sealing methods.

SYNTHETIC ELASTOMERS HALVE HELIUM LOSS FROM NAVY BLIMP

An all-synthetic envelope on a Navy blimp has reduced helium loss by half during four months of testing, according to officials of the U. S. Navy's Bureau of Aeronautics.

The envelope consists of two layers of "Dacron" polyester fiber, with an inside coating and binding layer of neoprene and an outside coating of aluminized "Hypalon" synthetic rubber. Total weight of the rubber-and-fabric laminate is approximately 15.5 ounces per square yard (525.6 grams per square meter).

The new covering is dimensionally stable, extremely strong and durable, and resists attack by weather, sunlight, and mildew. "Dacron" gives the fabric strength, durability, and dimensional stability, while neoprene provides impermeability. The exterior coating of "Hypalon" gives the covering a high degree of abrasion resistance and immunity to the deteriorating effects of oxygen, ozone, and sunlight.

In addition to the important savings in cost of helium, another advantage is the greater load of fuel and equipment made possible by the lightness of the newly developed fabric.

Navy spokesmen are enthusiastic about the performance of this all-synthetic envelope, and plan to continue the tests with additional envelopes of similar construction.

(Continued from page P.15)

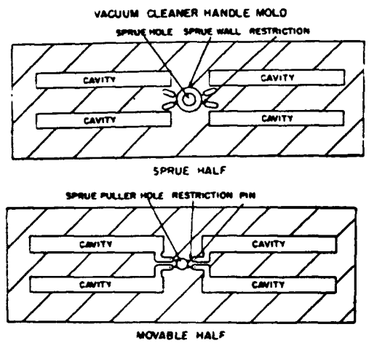


FIG. 8 — DIAGRAM OF GATING SYSTEM USED IN MOLDING HANDLE SHOWN IN LOWER PART OF FIG. 7

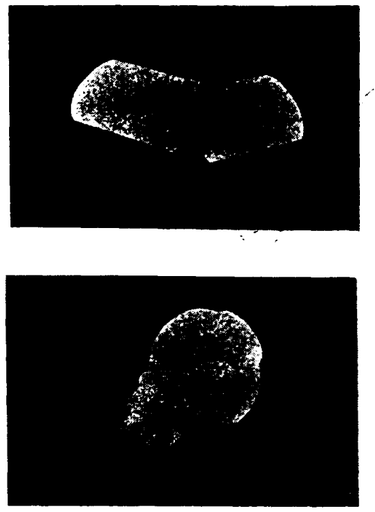
original design. The restriction and pin placed in each runner are responsible for the markedly improved appearance of the piece. The restrictions were 0.015 in. (0.4 mm.) in diameter by 0.060 in. (1.5 mm.) long. Each restriction is located approximately 3/16 in. (4.8 mm.) from the sprue and 5/8 in. (15.8 mm.) from the cavity entrance. Each pin is 1/8 in. (3.2 mm.) in diameter, extending from one side to the other of the 1/4 in. (6.4 mm.) full round runner and located 0.100 in. (2.5 mm.) from the restriction.

In line with the experience gained from the color checker mold, the large gate into the cavity is flush with the piece on one side and stepped down 0.010 in. (0.25 mm.) on the other.

It has been the intention of this Release to furnish detailed information on specific laboratory and field cases involving the use of the restricted gating technique. However, it should be pointed out that production experience with this technique has been greatly broadened since the initial investigation was conducted. The principles described in the foregoing pages have been and are being successfully applied to the production of a widely varied line of vinyl molded articles which includes vacuum cleaner brush holders and bumpers, automotive trim and gasketing, flashlight lens rings, and coil housings.

own manufacturing process as well as in applications of the products. This period also enabled them to introduce the new materials to manufacturers for evaluation on standard fabricating equipment.

A typical example of how Union Carbide's commercially available high density polyethylenes were thoroughly pre-tested prior to their widespread introduction occurred at the plant of a molder of packaging containers for cosmetics and drugs. The packaging firm, interested in the new materials, decided to test Union Carbide high density polyethylene DMDA-6001, a material which can be used for both injection and blow molding. The products chosen for the test were an industrial soap dispenser and a case for a perfume atomizer. The soap dispenser was blow molded from DMDA-6001, while the perfume atomizer case was injection molded. The manufacturer reported that the production runs of both units showed clearly that Union Carbide's high density polyethylene exhibited excellent flow characteristics and proved readily adaptable to conventional molding techniques and equipment. The items made of this new material, after accelerated use tests, showed excellent resistance to stress cracking. High gloss of the finished products, thin wall strength, resistance to breakage, chemical inertness and resistance to grease and oils combined with manufacturing advantages to produce a finished product that was highly acceptable both to producers and consumers.



Two new products made of Union Carbide high density polyethylene are an industrial soap dispenser (TOP) and a perfume atomizer case (BOTTOM). Thin-section rigidity and strength, high gloss, and chemical inertness of these products are the combination of properties which made new Union Carbide high-density polyethylene particularly suitable.

To help develop the markets for the new high density polyethylenes, Union Carbide is offering test samples to both injection and blow molders the world over.

EXPORT OF ORE

In Parliament Mr. Nityananand Kanungo, Minister for Trade, told Mr. Mahavir Tyagi that the present contract with Japan for the export of ore was up to 1962.

Asked whether the Government of India had taken into consideration the possibility of Japanese competition in manufactured iron and steel material in the East Asian markets, the Minister replied : All these matters have been taken into account.

EXPORT OF CEMENT

Out of a total of two lakh tons of cement which was proposed to be exported during the current year, contracts had been signed for 25,000 tons and another contract for 75,000 tons was under consideration, Mr. Manubhai Shah, Minister for Industry, told Mr. Kodiyan. The Government's policy was to earn foreign exchange by the export of cement even at the cost of domestic needs. "We are determined to export more. However the contingency of domestic consumption suffering might not arise because production is also stepping up," he added.

The countries to which India exported cement were Pakistan, Ceylon, Singapore and Hong Kong.

PREcounted, PREpackaged, PREcision

Automatic Packaging of Small Hardware Parts

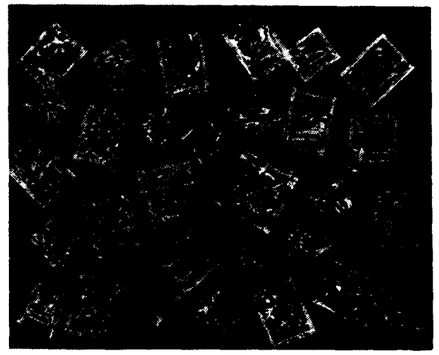
By A Technical Correspondent

HERE'S a packaging idea that helps manufacturers reduce production expenses. An American packaging corporation not only manufactures and supplies various types of standard fastener assemblies, but also plates, counts, sorts, and automatically packages them to customer specifications. If the customer prefers, his assemblies will be stocked and supplied to him as needed, prepacked and ready to use. Wood, tapping and machine screws, nails and tacks, cotter pins, nuts, bolts, washers, brackets—every kind of fastener can be economically packaged by this system. Special parts such as stampings and gaskets, supplied by the product manufacturer or other suppliers, can also be included in the packaged assembly.

To make the idea "go," a tough, transparent packaging material, capable of being automatically heat-sealed, was necessary. A polyethylene-cellophane laminate was selected because of the superior strength properties of the polyethylene film—made from UNION CARBIDE Polyethylene—this laminate resists puncturing from the packaged parts. Its high clarity permits easy identification and inspection. It will not cloud or embrittle with age. Its heat sealability, plus its performance on high-speed automatic equipment, results in a moisture tight, yet easy-to-open pack.

Automatic packaging machinery is relatively expensive, and it does not always pay an end-product manufacturer to undertake his own small part packaging operation. As for hand packaging industrial parts, the costs are unrealistic. It means low production rates, counting inaccuracy and complex inventory.

This new prepackaging system solves all these problems. By doing the manufacturer's small part packaging for him, by providing prompt delivery from stock, this complete system simplifies purchasing, reduces handling and ware-housing of bulk material, and helps the manufacturer keep to production schedules. In plain language—it saves him money—and at the same time, helps the packager's profits.



Everything from complex fastener assemblies to simple screw sets are economically prepacked and supplied in puncture-resistant polyethylene-cellophane. Size of the packages range from 1½ inches x 1½ inches (3.7 x 3.7 cm.) to 6 inches x 10 inches (15 x 25 cm.)

Metal for Nuclear Reactors Shipped in Polyethylene-lined Drums

PACKAGED FOR POWER

Film made from UNION CARBIDE Polyethylene is now used as a drum liner to package zirconium sponge. Zirconium, in its purest form, is one of the most valuable of modern metals. Combining strength and low neutron absorption with high resistance to corrosion and heat, it is used extensively as a structural material for nuclear power reactors as well as for chemical processing equipment.

In the actual packaging procedure followed by one of the world's largest zirconium producers, the bags are placed in 3½ gallon (13.5 liters) pails and filled with the metal. After the top of the bag is folded over and the steel cover put on loosely, the complete unit is placed in an airtight chamber. Here, the air is evacuated and replaced with argon gas. The steel cover is then secured, and the entire package placed in a wooden box for shipping.

The use of the film in this application is strictly

Polyethylene film liners are recommended for the shipment of zirconium sponge because they protect the valuable metal from contamination.

After being filled to the proper weight with metal sponge, the tear-resistant bag is gathered at the top and folded.

functional—it helps ensure that the product is shipped and received in excellent condition. The film resists tearing and the abrasion of the metal sponge, preventing this valuable material from being contaminated by contact with the steel drums. The bags are two mils thick and measure 10½ inches by 9½ inches by 27 inches (26 × 23 × 69 cm.).

What profit potential does such a specialized application offer the packaging supplier? More than you may think. This company alone expects to produce about 1¼ million pounds (576,508 kgs.) of zirconium during 1958. Looking at specialty applications from a multiple sales standpoint, we in polyethylene packaging probably haven't even scratched the surface. Investigate—the versatility of polyethylene film and coated packages may bring you profits in fields you never before considered.

BEST FOR HOPS

Polyethylene Film Barrier Protects Beer Ingredients

Yakima, Washington, to New York City—2,954 miles (4,755 kilom.). Cutting shipping costs and reducing spoilage losses on a distance such as this would be a joy to any manufacturer. And, this is exactly what suppliers of hops to the brewery industry can expect if their product is packaged in double-compressed bales covered with film of polyethylene. The designers of this packaging technique report that savings up to U. S. $ 1.25 per 100 pounds (45.4 kgs.) have been obtained on 75,000 pounds (31,980 kgs.) of hops shipped from Yakima to New York.

What made this package click? Simply—a fresh idea plus effective use of the best possible packaging materials. The idea: recompress bales of hops

The double-compressed bale (small size left, full size right) requires one-half the space of the conventional bale (center) and provides airtight, waterproof protection for the hops.

(full or small size) to half their original size; encase them in polyethylene film or film bags; heat seal the film; place the package in a sealed water-resistant carton. The result: a neat, compact, easy-to-handle, waterproof, airtight package that permits larger unit shipments, requires 50 per cent less storage space than conventional bales, and preserves the quality of the hops.

Because of polyethylene's protective characteristics, product deterioration is negligible. The film guards the hops against harmful moisture penetration and minimizes oxidation. It also helps keep the hops' aroma in, foreign odors out.

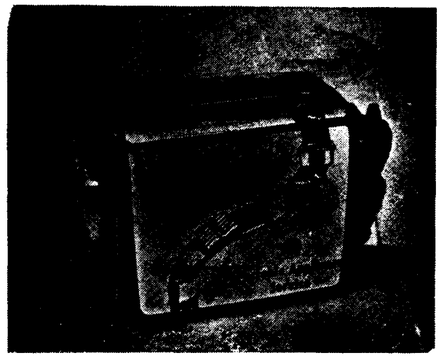
The success of this packaging method is proved by repeat orders from hops suppliers. After all, what better performance criterion is there than customer satisfaction.

For complete information on this application, please write directly to the Tri-State Processing Company, 209 North 2nd Ave., Yakima, Washington, U. S. A.

SERVICE WITH A SPARKLE

Repaired Appliances in Printed Film Bags

Glistening, attractively printed polyethylene film bags used at Westinghouse Corporation's service depots, are giving repaired portable appliances a "new look". The appliances—toasters, irons, coffee makers, frying pans, mixers, heating pads—are immediately placed in the bags when received at the depot to protect them against dirt and scratches. When repaired, they are returned in the bags as clean as when shipped.



The bags, brightly printed in orange and blue, give the repaired appliances a look of newness.

These film bags, made of UNION CARBIDE Polyethylene, are supplied by The Dobeckman Company in two sizes—10 in. by 6 in. by 18 in. (25 × 15 × 46 cm.) and 5½ in. by 4 in. by 14 in. (13 × 10 × 35 cm.)—large enough to accommodate the entire line of "Westinghouse" portable appliances. Easy to handle, the bags save time for the repairmen—no tying or sealing device is necessary—just a quick, simple fold.

(Photos: Courtesy: Union Carbide International Company, New York.)

NEED FOR CONTROLLING CORROSION OF STEEL

Dr. B. N. Dey, retired Chief Engineer of Calcutta Corporation and a well-known Consulting Engineer, stated that India's planned six million ton steel production could be made to equate to a ten million ton steel production with effective corrosion-control.

In a statement, Dr. Dey said that it had been found that the higher the steel production of a country, the higher would be its corrosion. It had also been variously estimated that up to nearly half a country's steel production was used up in replacing the corroded material, so that only half of its steel production was available for new construction.

According to Dr. Dey, the cost of protecting and prolonging the life of steel by the latest methods being within one-tenth of the cost of producing steel, it is clearly a case of big economy.

*** *** ***

PAINT WARNS OF DANGEROUS HEAT

A new paint developed by an American company gives a visual warning or alarm when objects painted with it get too hot. The paint is brushed or sprayed on metal pipes and boilers and will change its colour from blue to white when the temperature reaches 585 degrees Fahrenheit. The manufacturer of the paint is the Humble Oil and Refining Company of Houston, Texas.

Paints and Industries

By

Asoke Chandra Bhattacharya

PAINTS provide the means for giving beauty and colour and cheer to the common things of life. As one looks around the cities and various other objects, one realises how much the community owe to the brightness and colour of paint.

Glimpses of the pre-historic periods will give an interesting reading of the employment of colour, closely associated with the artistic and aesthetic outlook of contemporary civilization. The paintings that are found in the caves of Ellora and Ajanta are the matchless creations of the artists of that time.

Paint, which was once purely associated with art, has now come to be employed in diverse ways, in our homes and factories, in shipping and aircraft, on farm equipment and industrial machinery. In fact, wherever metal or woodwork require protection or decoration, paint in one of its many forms will be found; without it the vast installations of modern industry would quickly be reduced to scrap.

The paint and varnish Industry, which was for a considerable period in the background, has now grown into a chemical industry of the first magnitude in the wake of a new era associated with the development of paints and surface coatings. Constant researches in the evolution of new formulae for the introduction of new products to meet specific needs of the various industries, by eminent scientists and chemists have brought about tremendous improvements in the line. These products range from automobile and industrial finishes, synthetic enamels, ready-mixed paints, varnishes, wax emulsions, plastic emulsion paints, etc., and cover almost all types of surfaces that require a paint finish. It is for this reason, the paint industry has not only come to stay as an industry by itself, but it has become a handmaiden and an essential part of the majority of other industries.

MANUFACTURE OF PAINT

A paint can be defined as a surface coating of colouring and preservative matter applied in liquid form. It consists of two elements, a "base" and a "vehicle". The base is usually a powder ground to stiff paste, which forms a covering medium or body of the paint, whilst the vehicle is to dissolve it and hold it in suspense and enable it to be applied.

The manufacture of paint is an extremely complex process and is largely chemical and is, in fact, a branch of the chemical industry.

Briefly, the process consists of taking a variety of raw materials, dispersing pigments in drying media—oils and varnishes in correct proportions. The pigments used are fine coloured powders, either naturally occurring earth colours or chemically manufactured preparations, and their origin is a fascinating study.

In ancient days the most famous colour of all, tyrian purple, was obtained from a shell fish and, on account of its high cost, was used for the robes that marked Imperial rank.

The following centuries saw the continual development of new pigments and in addition to the familiar Ochres, Umbers and Siennas, one finds a long list of romantic names, Turkey Red, King's Yellow, Vandyke Brown and Malachite Green, now discarded for its poison content.

Today synthetic dyes, which were developed after some of the most brilliant work in the history of chemistry, have made available to the industry a magnificent range of new pigments.

The manufacturing process of paint embodies the following sequences of operation :—

1. Receiving materials and conveying to Store.
2. Taking materials from Store, weighing and proportioning.
3. Loading into paste mixers or pugs.
4. Discharging from paste mixers to mills.
5. Receiving into containers or tanks.
6. Tinting in tanks or paint mixers and thinning.

7. Weighing or measuring into saleable containers.
8. Moving to finished warehouse.

The varnish making generally follows the course of operations as under :—

RAW MATERIALS—GUMS

1. Receiving rosin and natural gums and conveying them to Store
2. Receiving from Store, cleaning
3. Weighing and charging to reaction vessel
4. Gum running

OILS BODYING

1. Receiving of oils
2. Pumping to storage tanks
3. Measuring into reaction vessels
4. Processing oils, such as preparation of "Stand Oil", "blown oil" and "dehydrated castor oil ". Hydrogeneration.

Coming again to paint making, various methods of pigmenting paint media are in use to-day and one of the most popular is the Paste Process.

In this process, the pigment is mixed with a portion of the total paint medium using a heavy paste mixer. After a preliminary mixing, the resulting paste is milled on a multi-roller mill. A thinning mixer is then employed to produce the liquid paint, linseed oil or varnish and spirit being used as the thinning medium. For production of quality paints, the liquid paint is refined in a refining mill before being finally packed in containers.

SEMI-PASTE PROCESS

The modern way of pigmenting paints is the " semi-paste " method which is widely used throughout the industry for the production of enamels and higher grades of liquid paints. In this process the total pigment is mixed with a portion of the media in a suitable mixer and then milled out.

The importance of pre-mixing in paint manufacture cannot be overemphasized. It has in fact a great influence on the resulting product. By arranging for a certain degree of consistency and viscosity of material, conditions can be created during the process of pre-mixing whereby a rate of " shear " is induced that will break down aggregates and will actually wet and disperse particles.

The heat of wetting is another influencing factor in premixing. For example, lithopone and linseed oil have a heat of wetting or immersion of approximately 0.5 calories per gramme of pigment. If conditions in the mixer are such as to satisfy the energetics of wetting, it will be found that a certain useful amount of dispersion will have taken place.

MILLING

The purpose of milling is to separate the agglomeration into particles and wet them thoroughly, which means breaking down of aggregates and the surrounding of the resulting particles by liquid medium rather than the actual fracture of particles. The satisfactory accomplishment of dispersion and wetting is dependent upon the rate of " shear " and the control of temperature. On the material being passed between the grinding members, the shearing stress of the operation tends to reduce the particles and in this way assists in thorough wetting.

For the paint manufacturer, the control of temperature does not present any problem, since water cooling and other devices incorporated in the machinery, help to maintain a constant temperature. Viscosity and consistency of the material are two very important factors in the wet grinding of pigments.

With regard to the " film " of the paint, the aim is directed to produce one which would produce the maximum frictional inter-activity between particles.

BALL OR PEBBLE MILLING

Ball or pebble milling represents a short-cut method of manufacturing paint. In this case the total pigment is put into the mill with a proportion of medium.

The mill, which at times are lined with porcelain or silex blocks, contains a large charge of steel or porcelain balls, or sea-shore pebbles. Milling period is anything between eight hours to ninety-six hours, depending upon quality, before it is thinned, brought to shade, and packed. In some cases the products instead of being fed to thinning tanks, are passed through refining rolls before being canned.

sticky that the balls stick together, or too thin so that the balls rub together and do not disperse the material. Pebble mills are generally used for processing pigments which are easily dispersed.

The methods described in the preceeding paragraphs may be considered as conventional and traditional and, whilst they have many advantages they are still capable of further improvement.

PAINT MACHINERY

The correct formulation of a paint would in itself not be sufficient if suitable mechanical appliances were not available to wet the pigments thoroughly and to disperse them evenly and finely in the various types of vehicles. The durability, the yield, the cost and lastly the quality of paints depend largely on the use of the appropriate paint machinery, some of which are discussed in the following paragraphs.

EDGE RUNNERS

This machine has been in use in the paint trade for a very long time and is almost a necessity in the manufacture of paint by the paste process. Since the demand for paste paints has registered a decline in recent years, this type of machine is now largely used for the preparation of distempers and dry colours. Illustrated in Fig. 1, is the 7 ft. edge runner developed by Sidney Smith

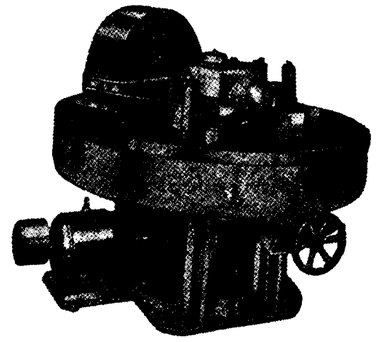


Fig. 1. 7 ft. edge runner.
[Sidney Smith (Industries) Ltd.]

(Industries) Ltd. It is capable of machining batches up to 17 cwt. and is designed to combine sturdiness with simplicity. The mill is silent in action because of the bearings being of the roller type and is fitted with a reversing switch, which is a considerable advantage when the mill stops due to banking.

TRIPLE ROLL MILLS

Triple roll mills are largely used in conjunction with edge runners for the dispersion and fine grinding of pigments and other substances in paste form. Depicted in Fig. 2, is the Brinjes and Goodwin 24 in. by 12 in. triple roll mill in the

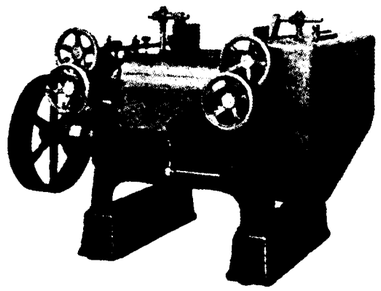


Fig. 2. The Brinjes & Goodwin 24 in. by 12 in. Box-frame type triple roll mill.

range of multi-roller mills manufactured by the Vickers-Armstrong Group. The rolls are made of chilled iron. The design incorporates a box frame construction giving great strength and rigidity without undue weight. All controls are worked from the front of the mill. Where the machine is required for soft colours or where the substances to be ground are of a slippery nature, granite rolls are recommended. Another type of Triple Roll Mill made by Torrance & Sons Ltd., and having the roll size of 30 inch by 15 inch is shown in Fig. 3.

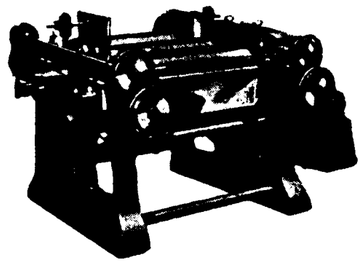


Fig. 3. Torrance Triple Roll Mill.

SINGLE—ROLL MILLS

The single-roll mill is one of the most popular mills in general use, and although it is essentially a refining mill, it can be employed in three distinct types of duty :— (a) Wetting and dispersing into ready-for-use state of easily wettable and soft pigments already pre-mixed with appropriate media in a suitable mixing machine; (b) refining, finishing or straining of paints and kindred products after milling and thinning ("tinting"); (c) production of certain heavily pigmented industrial paints, such as iron oxide anti-corrosive and anti-fouling paints for ships and ready-for-use white lead paints, as well as undercoats, flat paints and the like.

Single-roll mills are made in two types, single bar and double bar (two stage). While the former is generally used for single straining operations as well as for the refining or dispersion of paints containing very soft and easily wettable pigments, the latter deals in one passage only, with materials which would require two passes through a single-bar refining mill.

UNIROLL MILL

The Uniroll mill, as illustrated in Fig. 4, is the

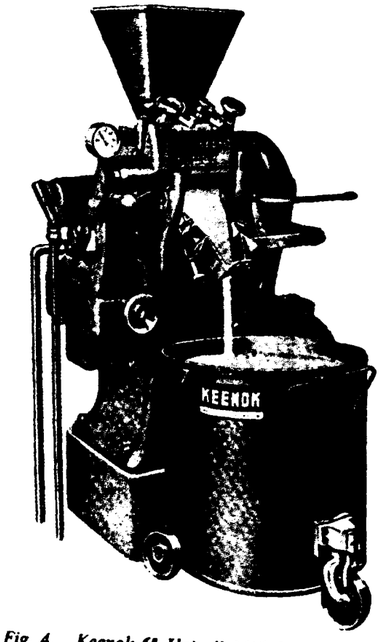


Fig. 4. Keenok 6" Uniroll Mill fitted with clutch.

invention of the late Mr. Asbjorn Sonsthagen, the founder of Keenok. It is now recognised as a very useful semi-paste mill for enamel and is employed in the production of soft pastes, semipastes and liquids and the milling of mixtures of low and medium viscosity, including raw or boiled linseed oil, light and medium linseed stand oils, oil, gum and spirit varnishes, synthetic resin solutions, spirit, gum and shellac solutions, spirit and goldsize mixtures, plasticising fluid for cellulose, and special water solution and emulsion media such as casein, borax and sulphonated oil solutions.

MIXING MACHINERY

Mixing machinery is another very important item of plant required for paint manufacture. Good results in paint grinding depend to a great extent on good pre-mixing of the ingredients. Mixers are, however, not only used for pre-mixing before grinding but also for blending different coloured enamels or mixing ground paste and vehicle.

Shown in Fig. 5, is the Keenomix Pre-mixer which shears as it mixes. It is designed to operate

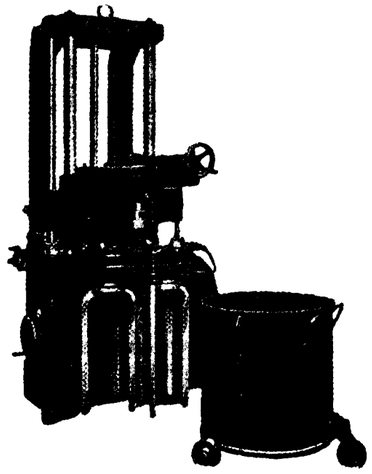


Fig. 5. Keenomix Pre-mixer.

with 50 gallon containers, the blades being lifted and lowered by hydraulic control.

PAINT FAILURES

Before discussing about the process of painting, it would be proper to be familiar with possible defects in painting which interferes with the preservative value of the composite film owing to some kind of rupture which destroys its continuity. A few of the common failures are (i) Crocodiling (splitting of paint between coats), (ii) Reticulating, (iii) Blistering and Cracking, (iv) Bleeding or Bleaching, (v) Blooming (turning a dull purplish hue), (vi) Livering, (vii) Cessing, and (viii) Flaking on Metal.

The reasons for failures are either due to the deterioration taking place in the paint itself or in the method of its application. The deterioration of the paint is usually caused by (a) Water (dissolution), (b) Light and heat (chemical & physical change), (c) Chemical reaction between pigment and binder (disintegration), (d) Abrasion, and (e) Action of deleterious gases (foul air).

As regards the method of application, the failures mentioned earlier are attributable to the causes indicated against each.

1. Crocodiling —(i) Applying paint over wet paint.
   (ii) Applying quick dry paint over paint mixed with a large percentage of oil.
   (iii) Rubbing down with rubbing bricks and water on the wet surface or when the surface has not properly dried up.
2. Reticulating —Vigorous flatting down with coarse pumice powder or rubbing down with bone cuttle fish on the coat prior to finishing coat of varnish.
3. Blistering and Cracking —(i) Painting over unseasoned timber
   (ii) Too much oil in the priming coats or filling coats.
   (iii) Presence of water or moisture between coats or sealed beneath.

4. Bleaching of Paints	—This usually occurs with reds, chiefly paints of red lead base and is caused by the sulphurous fumes in the air	
5. Blooming of varnishes	—(i) Addition of turpentine to varnish,	
	(ii) Applying varnish in a damp atmosphere	
6. Livering	—(i) Too thick application of oil paints	
	(ii) Using coal and gas tars or bitumastic solutions in conjunction with oil paints	
7. Cessing	—(i) Applying paint in a damp atmosphere	
	(ii) Not varnishing or enamelling a job immediately after flatting down	
8. Flaking on Metal	—(i) Presence of rust, grease or moisture on the surface painted	
	(ii) Expansion and contraction of the surface in excess of what the paint can stand up to	
	(iii) The absence of Key on the surface	

PROCESS OF PAINTING

The basic painting process involves :—

(i) Primer to give adhesion, corrosion resistance, etc.

(ii) Filler or surfacer which, as the names imply, fills the imperfections of the metal so that a smooth uniform surface can be obtained by the rubbing down or "flatting" operation which is carried out on this coat.

(iii) Finishing coats, by which the final appearance and weathering resistance are obtained.

In the process of painting, faults in the ground work, such as resinous and damp places, rough and uneven surfaces, holes and anything which is likely to affect the after work, must be dealt with at the outset.

A coat of paint should never be applied till the one below is thoroughly dry. It must be applied timely so that it can harden quickly. Too much paint is as bad as too little. In using the brush, the same amount of pressure should be exerted all over the work, otherwise there will be a want of uniformity in the appearance of the finished surface.

Every endeavour should be made to work each coat of paint so as to make all similar in nature, equally elastic and equally dry to ensure that one coat will assist the others in acquiring solidity of surface and colour. The importance of examining

the surfaces for their fitness to take up the paint from the very initial coat of paint cannot be too strongly stressed.

It must be remembered that work which has been well glass papered will at the finish, result in a better surface than can be otherwise obtained. Dirt is thus removed also nibs and irregularities which no after painting can conceal. A brush mark or flaw in the first coat, unless removed, will show in the last coat, no matter how many coats are applied.

There is hardly any connecting link between the surface of the material and the priming coat and some means has to be found so that the paint may be firmly attached to the surface. Unless this bond is secured for the priming the application of further coats of paint will be useless.

In re-painting old work, removal of all grease, damp, and dirt should be done first followed by the repairs to bad places. If the work is in a fairly good condition, a good wash with water and small quantity of soda is sufficient,—the more the grease and dirt, the more the soda—but the solution must not be so strong as to remove the paint. The hard outer surface of the paint should be removed with pumice stone to ensure the adhesion of the successive coats.

PAINTS & INDUSTRIES

Shipping, railways and automotive industries are by far the largest consumers of paint and are very much dependent on it both for protection against corrosion and good appearance.

Paint is no longer regarded as merely a coating by the industrialists but is being extensively used to-day to increase industrial efficiency. A planned way of painting a factory including the machinery and plant is fast becoming a standard practice to provide for a production incentive through the psychological use of colour in paint.

Freshness and colour, two features for which industry largely depends upon paint, are the keynotes of practically every decoration initiated by the architects and designers.

Modern industrial finishes of materials, such as the onerous requirements of refrigerators, satisfactory finishes for wooden furniture, coating of leather, interior and exterior coatings for food containers are very much dependent on the paint manufacturers for the supply of right type of paints required.

Until the advent of World War II, the paint industry in India was very much lagging behind and the requirements were mostly met by imports. To-day, however, we have made a considerable headway in this connection with the establishment of a number of units and in the years to come, it is expected that more will be set up consistent with the future demands to be met.

B K - 3962 RESIN DISPERSION

GENERAL DESCRIPTION

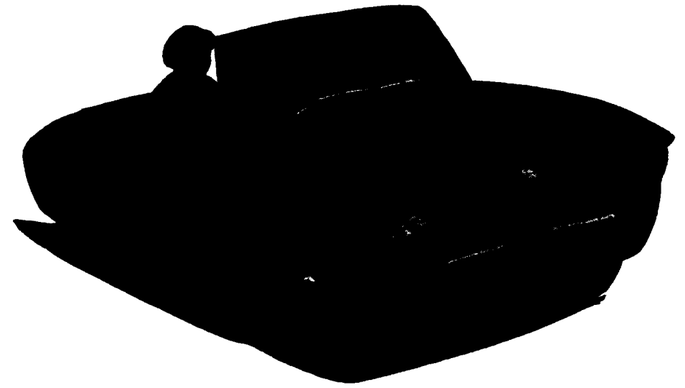
BK-3962 is the original, most widely used dispersion. It is an opaque, cream-colored, viscous liquid. Of the two currently available dispersions, BK-3962 produces the quicker drying, harder films having the better water and solvent resistance. It may be used alone for some special applications, but for most protective coatings where flexibility is necessary, it should be modified with oleoresinous varnishes, alkyds, or chemical and resinous plasticizers.

BK-3962 alone produces films which have the desirable property of non-penetration when applied to porous surfaces, such as concrete and wallboard. Such films have good continuity, adhesion, and impermeability to moisture.

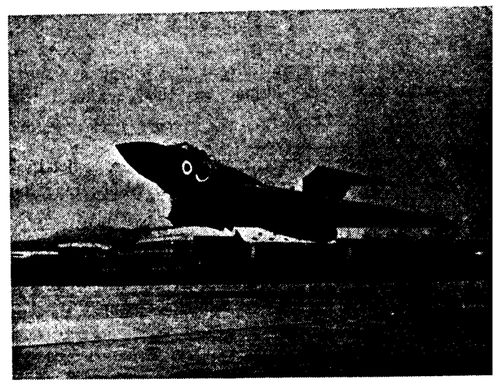
BK-3962 formulations must be thinned with aromatic hydrocarbons, such as xylene and toluene. They have a very slight tolerance for aliphatic hydrocarbons and, therefore, films based on BK-3962 show excellent resistance to ordinary gasoline. Finishes based on BK-3962 can be recoated with lacquers or other materials containing powerful solvents within a few minutes after the dispersion coating has been applied.

FORMULATION

Dispersion BK-3962 is used alone as a coating for porous materials, such as concrete or wallboard; but for most other coating applications the dispersion must be plasticized with varnishes or alkyds. Such combinations also dry quickly because of the dispersion and are more durable because of the increased film thickness and toughness derived from the varnish or alkyd. BK-3962 has less oil compatibility than BK-16624; therefore, any plasticizing material used must be chosen carefully.



AIRCRAFT AND AUTOMOTIVE INDUSTRIES SECTION



This is the Story of the Brockworth works of Armstrong Siddeley Motors Limited

From A Technical Correspondent

AT the foot of the Cotswolds in the rolling West Country of England, jewels of beauty, precision and power are being produced. They are gems of engineering skill—the world famous Armstrong Siddeley Sapphire jet engines.

The Sapphire powers 14 of the world's leading military aircraft and has probably earned more foreign currency than any other British aero engine. It is being built under licence in the United States where it is known as the J. 65.

When the Hawker Siddeley Group decided on the nass production of Sapphires, it announced its ntention of creating the most modern jet engine actory in Europe. The chosen site was a wartime hadow factory at Brockworth, built to serve the eighbouring Gloster Aircraft Company. After the ar the factory went over to the production of refabricated aluminium houses, but, with the mphasis again on armaments, the Government pproved the scheme for the production of gas irbines in the Gloucester area. In 1953 Brockworth ngineering Company, now Armstrong Siddeley lotors Ltd., Brockworth, was formed.

Factory space was only one of the problems. here was the difficulty of finding sufficient skilled bour in a rural community. To solve this, a ation-wide advertising campaign was carried out. killed workers were offered "A job after your own art" and "A home in the beautiful West ountry".

Scottish engineers from the Clyde, quiet-spoken en from the western valleys of Wales, machinists, ters and draughtsmen from the smoky cities of e North of England answered the appeal. They ere attracted by the prospect of being in at the art of a great new development by Britain's largest ganisation—the Hawker Siddeley Group.

The effects of the cold war on Britain's peacetime habilitation were nowhere better expressed than in e Brockworth factory. Planning engineers, machinists and fitters took over while prefabricated houses were still in production. As the building teams moved along the floor, the engineers and their equipment followed. Gradually, the machines pushed out the houses and mass production of Sapphires began.

The new industry caused no small impact on the lives of the rural community. Three housing estates were planned and the first two, totalling 500 houses, have been occupied for some time. A third, of 150 houses, is now nearly ready. All three estates were planned and built by a member of the Hawker Siddeley Group–the Hawksley Construction Company.

Morale was excellent. The men shared a common experience, getting to know their machines and each other; settling down into new houses and helping one another in the decorating and gardening; finding schools and arranging transport. The works people formed their own Tenant's Association and, as there were no ready-made social amenities, set about providing them. They formed a club, an Amateur Dramatic Society, and arranged parties and pantomimes.

It all helped to foster the best possible team spirit. As community relations developed, production was speeded up and the venture began to pay off. New Marks of Sapphire, designed at the main Armstrong Siddeley plant at Coventry, began to flow from the production lines in the West Country. Within three years, the Brockworth company took over production of all Sapphire gas turbines, apart from the prototypes still being built at Coventry. As the Company's modern facilities and reputation came to be known, the firm obtained additional work.

There was a contract from the Canadian Government for the overhaul and repairs of all Avro Canada Orenda gas turbines—the engines which power the RCAF F. 86 in Europe. The contract also included the supply of servicing parts to all RCAF squadrons in Europe. The large number of J. 65-powered American Thunderstreak fighters flying with NATO forces in Europe also prompted a need for a constant flow of components. These aircraft, it was realised, could be better sustained in Europe than via the long Atlantic pipeline.

Tenders were invited from European engineering firms but Armstrong Siddeley, with its vast experience in engine manufacture, was finally chosen as a prime source for major parts.

British experts, who designed and produced the Sapphire and went to the U. S. to line up production of the J. 65 for Curtiss-Wright, had the unusual experience of seeing their own product come back home to them from the other side of the Atlantic, changed in certain manufacturing particulars, and then helping with its production under the scrutiny and inspection of American engineers.

SAPPHIRE MODEL 346

6 cylinder 90 x 90 mm. 3435 cc. 209.64 cu. ins.
Compression Ratio 7.0 to 1 R.A.C. Rating 30.13 hp.

Fully Automatic Transmission System or Synchromesh Gearbox
Brakes 12 in. Girling hydraulic with Vac-Hydro Servo Assistance

Twin Carburettor
150 B.H.P. @ 5,000 R.P.M.

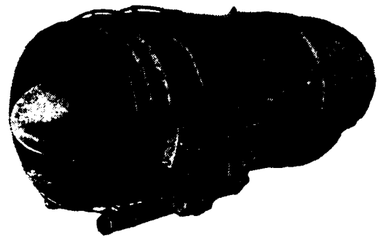
Single Carburettor
125 B.H.P. @ 4,700 R.P.M.

The Saloon body is extremely roomy having seat widths of over 53 inches. Bench type front seat is standard, but separate bucket type front seats are available as an extra. The upholstery is leather and all interior woodwork is polished walnut. The luggage boot has a capacity of 17 cubic feet and the spare wheel is in a separate compartment.

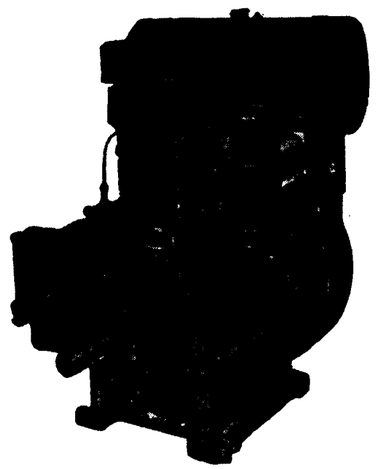
Controlled Power Steering may be fitted as an extra. The degree of assistance can be varied from nil to full power by a small lever on the dashboard. Adjustable ride control is also available, the degree of damping being controlled by a convenient knob at the bottom edge of the facia.

Bitteswell Aerodrome, Near Coventry. The Flight Testing Station for Armstrong Siddeley Motors Ltd.

Front Row, left to right, Sapphire Meteor, Fairey Gannet with Double Mamba, Westland Wyvern with Python. Second Row, Sapphire Canberra, Blackburn YB1 with Double Mamba, at back Sapphire Lancastrian Flying Test Bed.



Sapphire 7 Turbojet.
In Production at Armstrong Siddeley, Brockworth.



Twin Cylinder Air Cooled 14/22 horse power Diesel Engine.
In production at Armstrong Siddeley, Brockworth.

A Ferranti Electronic Computer at the Engineering and Research Centre of Armstrong Siddeley Motors Limited, at Ansty, near Coventry. There are only three others of this type in the Country.

As an outcome of the J. 65 enterprise, later Marks of Sapphire are now being sent on order to Curtiss-Wright—an example of America's continued interest in British aero engine development.

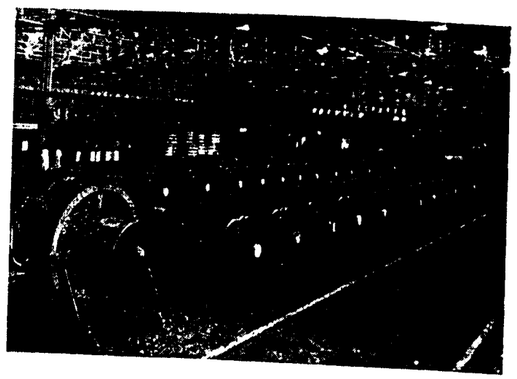
The Anglo-American enterprise is a successful fusion of the unequalled British technique for developing new gas turbines and the American genius for mass production. At Brockworth, top British and American engineers are working together on the original Sapphire and the American concept. The partnership, as well as being the very embodiment of Anglo-American co-operation, is of the utmost strategic value. The Brockworth factory maintains a comprehensive flow of spares to operational squadrons in Europe and can, if called upon, produce the entire J. 65 engine.

Another benefit resulting from the Anglo-American partnership is the fact that British and American engineers have become accustomed to each other's differences in specifications and technical terminology and different process of manufacture. The British have a flair for aero engine design and the average skilled worker is a good operator. In the States, more reliance is placed on the machine than on the man. Because of the greater production needs in the States—more than 10,000 J. 65s have been produced—it is possible to obtain the finest and most up-to-date machines. The difference in emphasis and the U. S. need for inter-changeability constitute the major contrast in U. S and British production methods.

The combined effort has resulted in the Sapphire and J. 65 being the chosen power plant for the following impressive list of aircraft:— **BRITISH**: Hawker Hunter, Gloster Javelin all-weather fighter, Avro Vulcan bomber (prototype), Handley Page Victor bomber, English Electric P. 1 (prototype), first British aircraft to exceed the speed of sound in level flight. **U. S.**: F. 84 F Thunderstreak, R. F. 84 F Thunderflash, B. 57 Canberra, A 4 D Skyhawk, F. J. 3 Fury, Lockheed F. 104, Grumman F 11 F-1 **SWISS**: P. 16 Interceptor. **FRENCH**: SNCASO Vautor (third prototype).

The Brockworth plant was chosen by the Ministry of Supply as being most representative of the British aero engine industry when a party of top Russian military and civil air experts visited Britain. The Soviet Minister for the Aircraft Industry, Mr. Dementiev, and his top engine designer, Mr. Svischev, after inspecting some of the unclassified features of Brockworth, said they were tremendously impressed by the standard of production shown and the facilities available to Britain's aero engineers.

In the Brockworth Inspection Department are standards rooms equipped with the most advanced and supersensitive equipment, some of it equalled only in the National Physical Laboratory. In these rooms the standards of measurement and gauging are set, against which components of the gas turbines can be checked to extremely fine tolerance.



Sapphire Turbojet production at Armstrong Siddeley Motors, Brockworth, near Gloucester.

Temperature control apparatus maintains large roomy laboratories continuously at 68° F. This ensures continuity of work in all weather on measurements capable of splitting a hair thousands of times, which would be hopelessly distorted by the expansion and retraction of metals at changing atmospheric temperatures. In some factories, work of this kind has either to be sent out to such centres as the National Physical Laboratory or delayed until conditions are right. At Brockworth, dealing with precision-made items such as turbine blades at the rate of thousands a day, such delays would be crippling.

Equipment includes the only machine of its kind in the country which enables quick, accurate setting of gauges for the complex, multi-dimensional checking of turbine blades; another machine specifically designed to cope with the accurate measurement of ball and roller bearings, as well as the finest equipment available for every type of checking and testing concerned with the production of gas turbines.

In addition to these extensive facilities in the factory, large new engine test houses have also been built at Brockworth. With ten test cells laid out side by side, each separately sealed and silenced, the test house is capable of working continuously, running several engines at a time at various stages of test as they are delivered from the production lines. A fully equipped instrument shop is also attached to ensure continuous maintenance and on-the-spot control of all the test bed instrumentation.

The unsurpassed facilities of Brockworth are available to all members of the Hawker Siddeley Group. Latest American policy of a "prime contractor" responsible for the entire production of airframe, engine and equipment is already paralleled to some extent in the Group which, from its own resources, has built and powered many of the aircraft now in RAF service.

PRODUCTION TARGET REACHED

Celebration at Kamani Factory

The Kamani Engineering Corporation Ltd., celebrated the achievement of the target production of 1,000 tons of transmission line towers in the month of May.

At an informal function held in their factory at Kurla, silver tokens were presented to every worker who participated in the Company's drive to achieve the target production. Shri R. H. Kamani, Chairman of the Corporation presenting the silver souvenirs said, they were a symbol of spirit and enthusiasm, "which I trust will inspire you further for achieving even greater success in future."

Shri P. R. Kamani, Managing Director of the Corporation said that the Corporation was aiming at a higher target of 1,500 tons per month which, he hoped, would be reached before long. The achievement, he thought, was all the more noteworthy considering the inadequate supply of steel and keen foreign competition.

Invitees were shown round various departments of the factory. The Kamanis supplied 50,000 tons of steel towers, which constitute about 66 per cent of the country's total requirements.

*** *** ***

SINDRI FACTORY EXPANSION PLAN

A 13-crore expansion programme of the Sindri fertiliser factory will soon be launched, it is officially learnt.

With the implementation of the expansion programme in the near future, it is stated that indigenous capacity for the production of fertilisers will be considerably stepped up and substantial foreign exchange conserved.

The programme will raise Sindri's capacity by 60 per cent and an additional plant has already been erected.

*** *** ***

NATIONAL EKCO RADIO

The accounts of the national Ekco Radio & Engineering Co. Ltd. were passed at the annual general meeting of the Company held on Tuesday, 12th August. Shri A. D. Shroff presided. The working of the Company during the year 1957 turned out to be better with a gross profit of Rs. 7 lakhs which has been adjusted against the carried forward loss of Rs. 21.81 lakhs. This is now reduced to Rs. 14.80 lakhs and is being carried forward. Sales increased to Rs. 60 lakhs from Rs. 39.61 lakhs. The production as also the sales of National-Ekco radios reached an all time record. The demand for the company's receivers during the first five months of the current year continued to be encouraging but the outlook would depend on import policy.

THE HANDLEY PAGE DART HERALD

From Our Overseas Correspondent

WHILE effort has always been expended on the design and construction of aircraft for the world's better-known routes, there have been few airliners designed to bring the same high standards of flight comfort to the branchlines where low purchase cost and economic operation are even more important than on the "prestige" services.

Until recently those wishing to fly or send goods on short haul routes have had to be content with obsolete mainliners designed for different conditions or with small aircraft offering little passenger appeal.

Recently, however, aircraft manufacturers have realised the vast potential market which exists for branchline aircraft designed for their job. Because of this resurgence of interest, operators using obsolete and unsuitable aircraft can now buy long-awaited replacements.

One modern interpretation of branchline operators' needs has resulted in the Handley Page Dart Herald. It is an aircraft which, besides being capable of operation from rugged terrain and in varied climatic conditions, brings new standards of comfort and performance to medium-range and local-service air routes all over the world.

Handley Page has been in negotiation for sometime with Indian Airlines with a view to beginning the replacement of the corporation's D. C. 3 fleet with Heralds during the next three years.

Heralds are also of considerable interest to the Indian Air Force, which is evaluating it as a replacement for the large D.C. 3 element in its Transport Command. Internal military transport is particularly important due to the vast size of the sub-continent of India and the length of frontier.

Advisors to the corporation are considering whether to get its possible requirements of Heralds direct from Britain or to have some of them built by the government aircraft factory, Hindustan Aircraft Ltd., under licence in India.

Carrying 43 passengers, over 4½ tons of freight or a combination of passengers and freight according to need, the Dart Herald cruises at 275 m. p. h. It carries its maximum payload of 10,160 lb. over a range of more than 700 miles; with a payload of 6,200 lb. its range is 1,430 miles.

As a military aircraft, its large double doors are suitable for loading military equipment and for supply and paratroop dropping.

This new branchliner's two Rolls-Royce Dart turboprop engines each give 2,100 e. h. p. for take-off. The first propjet engine to enter airline service, the Dart is backed by some four million flying hours of operating experience. No engine, piston or turboprop, enjoys a higher reputation for reliability, long overhaul life and small maintenance needs.

Pressurised, vibrationless comfort is the keynote of the Dart Herald's passenger cabin. Its size appeals to operators. It is, in effect, a pressurised tube 58 ft. long – stretching from the bulkhead behind the cockpit to the rear pressure bulkhead – and it has a volume of 2,075 cu. ft. Along each side are oval double-pane windows. The strong cabin floor will carry a load of a 150 lb./sq. ft. in the forward and rear freight areas and 100 lb./sq. ft. elsewhere.

There are two entrance-doors. One, on the port side towards the rear, is an outward-opening double-door 5 ft. 4 in. high by 4 ft. 5 in. wide. Its forward section only is used for passenger entry; both doors are opened for freight-loading. This double-door is standard; different types of rear door can befitted to special order. The other door, 3 ft. 10 in. by 3 ft., is on the port side at the front of the cabin and hinges outwards and forwards. Acting as both crew entry and access to the front of the cabin, it is large enough for the loading of such freight items as wool bales and oil drums.

In the standard version of the Dart Herald the cabin can be used for passengers, passengers and freight or freight alone. Rapidly removable seats and partitions allow changes of role to be made in a few minutes. Thirty-six passengers can be carried with a seat pitch of not less than 38 in. or a maximum of forty-three passengers with a reduced pitch.

When both freight and passengers are carried the cargo is stowed in the front of the cabin and the partition moved aft to one of several positions to seclude the passenger cabin, behind which is further cargo space.

When the aircraft is used solely as a freighter, the partition separating freight and passengers and that at the rear of the cabin, as well as the toilet, can rapidly be removed from the aircraft. A volume of 1,682 cu. ft. is then available for freight, leaving a clear gangway. Loading is simplified by the cabin floor being level and close to the ground.

As a standard arrangement, quickly-detachable low-weight double seats are used. They are stressed to withstand 9g. fore-and-aft loads. Changes of seating layout can be made rapidly.

FLIGHT DECK

Crew comfort has been studied at all stages in the design of the Dart Herald. Its flight-deck sets new standards for branchline aircraft in this respect.

Two pilots form the flight crew for normal operations and dual flying controls are fitted. A radio operator's position can be fitted aft of the flight deck at the expense of some payload space.

Both pilots have wide range of vision. When the aircraft is level on the ground objects less than ten feet ahead can be seen directly over the nose.

Control columns carry ramshorn handwheels and a smaller handwheel is fitted at the top of the first pilot's control column. This pivots upwards when required and is used to operate the nosewheel steering. Rudder bars can be adjusted to suit the reach of the pilots.

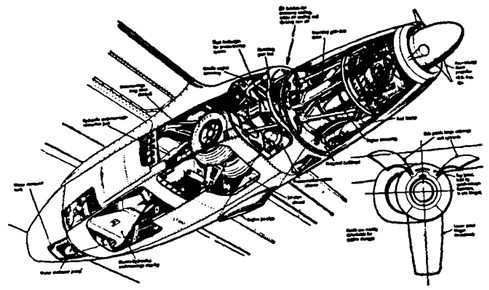
A safety feature which simplifies the pilot's task during take-off is an automatic-feathering system which depends on torquementer oil pressure for its operation in full-throttle conditions only. If an engine fails during take-off, its propeller is automatically moved into coarse pitch and the pilot need not feather the propeller immediately.

Layout of instruments and controls varies within limits to suit individual operators, as does that for radio navigational aids and pilot-aid installations. Care has been taken to ensure that instruments are adequately but unobtrusively illuminated for night flying.

Radio installations are close to the pilots' seats: they include communication, navigation and approach aid equipment. A standard radio-racking installation can be fitted in three alternative positions.

SERVICING AND MAINTENANCE

Ease of servicing and maintenance - essential for branchline transports - has been built into the Dart Herald from the initial stages of its design. Every effort has been made to reduce the amount of routine servicing needed and to ensure simplicity of, and easy access to, all airframe services.



Wherever possible, equipment for these has been grouped together so that components are readily accessible and not widely scattered about the airframe. Emphasis has been laid on interchangeability, the use of standard parts and avoidance of the need for special tools.

Hinged cowlings enable the engines and the components and pipelines in the engine bays to be reached easily.

Wherever possible, equipment has been standardised to avoid complication and to simplify the spares-holding problems of operators.

SERVICE TO THE OPERATOR

Airliners which bear the responsibility of flying at a profit in the most unpromising conditions of climate and terrain must be backed up by thorough and efficient support from the manufacturer. The Handley Page service provides technical publications, tuition, on-the-spot service engineers, technical liaison and a ready supply of spares.

Regional spares depots will be set up by the company, either directly or through agencies, in areas where Dart Heralds are operating. In addition, a

24-hour service will enable deliveries to be made at short notice to any part of the world from a central stock of spares. The company will also ensure that the supply of spares from outside suppliers is prompt and efficient.

Rolls-Royce turboprop engines have been in airline service since 1953 and the experience of the company is unmatched by that of any other engine manufacturer.

Rolls-Royce service to the operator is renowned. Potential operators of the company's engines can use the accumulated knowledge of its technicians even before the contract of sale is signed and continue to use it throughout the life of the engine.

Overhaul and repair of engines can be undertaken at Rolls-Royce factories in Derby, Glasgow, Montreal and Sydney. Specially-trained overhaul engineers can advise operators on the use of their own workshops for engine-overhaul.

ENGINEERING ASPECTS

Airframe

All-metal stressed-skin construction suits the Herald for service in a wide range of climatic conditions. The latest techniques have been used to ensure that its wing and pressurised fuselage have a fatigue life of at least 50,000 hours (nearly 17 years at 3,000 hours annual utilisation).

Fail-safe construction is used for the wing. Its tension and compression flanges are each made up of four separate units. If any one of these fails completely - which is unlikely - the remaining structure will be able to carry two-thirds of the ultimate design loading.

Copper-based alloys are used owing to their low crack-propagation qualities and their resistance to stress corrosion. In detail design emphasis has been laid on avoiding installation stresses.

Modern techniques which have been proved on Handley Page military aircraft are features of Dart Herald construction. Spot welding is used extensively on fuselage panels and spot-welded sandwich construction has been applied to the wing.

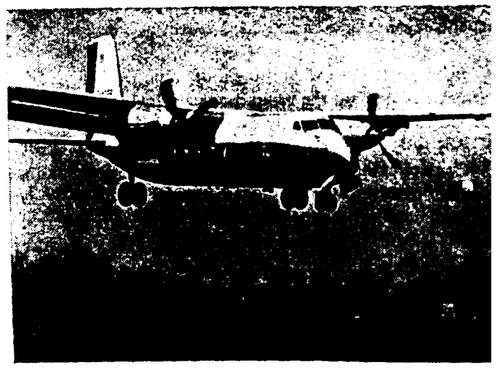
Otherwise conventional construction is used throughout the Dart Herald's airframe.

POWER PLANTS AND PROPELLERS

The Dart Herald has two Rolls-Royce R. Da. 7 series, mark 527, Dart propeller-turbine engines which each give at take-off 1,910 shaft horse-power plus a jet thrust of 505 lb. Total equivalent horse-power for take off is 2,100.

Main assemblies of the engine include an air-intake casing which surrounds the propeller reduction gear and incorporates an annular oil tank, a direct-entry two-stage centrifugal compressor, seven inter-connected straight-flow combustion chambers, a three-stage axial-flow shrouded turbine and an exhaust unit. Other features include an automatically-progressive water-methanol injection system, a torque-meter, a de-icing system for the air-intake duct and the supply of heated air for fuel-filter de-icing.

Engine speed is controlled by a single lever. Control of turbine temperature, necessitated by variations in ambient air temperature, is provided by a manually-operated fuel trimmer.



Handley Page Dart Herald

Maximum engine speed is normally governed by th propeller but, as an additional safeguard, an over speed governor is incorporated in the engine-drive fuel pump.

Each engine is mounted in a Vickers Viscount tubula engine-mounting at the front of its nacelle so that it jet cone projects back through a hole in the bulkhead A universal-drive shaft from the engine passes bac through the bulkhead to an auxiliary gearbox mounte in the nacelle. Through this gearbox are driven a 7.3

VA alternator, a Godfrey cabin blower, a hydraulic pump, a 6kw generator and a tachometer generator. The port gearbox embodies a device for propeller braking to stop the propeller from windmilling when the engine is not running.

There is a de-icing heat-exchanger on the jet pipe in each nacelle and the jet stream can be led into this through an actuator-operated door. It heats the air needed for aerofoil de-icing.

As the performance of the engine is affected by changes of ambient temperature, water-methanol injection is used to restore take-off power for hot-weather operation. Take-off power and thrust are increased approximately to the static value obtainable in I. S. A. conditions when the ambient temperature is above this figure. The use of water methanol does not affect engine speed or fuel consumption.

Fully-feathering, constant-speed Rotol propellers are used. They are four-bladed and of 12 ft. 6 in. diameter.

Forward of the firewall, the power-plant components for the Dart Herald are the same as those of the Viscount 810 series.

UNDERCARRIAGE AND FUEL SYSTEMS

The retracting tricycle-undercarriage is operated by a hydraulic system with electrically-controlled valves. Main and nosewheel units have single oleo-pneumatic shock-absorber struts with twin wheels mounted on stub axles.

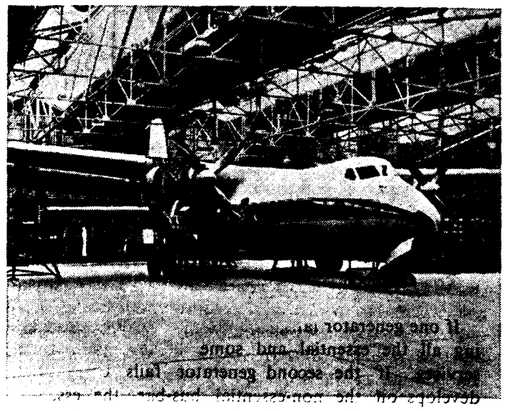
Main units retract forward into the nacelles along side the engine jet-pipes. These units are interchangeable between right and left-hand nacelles.

The nosewheel unit is of simple cantilever construction and retracts forward into an unpressurised bay in the nose of the fuselage. The nosewheel is steered hydraulically through an angle of 110° from a wheel on the first pilot's control column.

Goodyear wheels, tyres and brakes are used. Low pressure tyres enable the Dart Herald to operate from grass airfields. Main wheels have hydraulic disc-brakes. Anti-skid units can be fitted to special order; they prevent excessive tyre wear.

Fuel is supplied to the engines from four flexible and two integral wing-tanks. Flexible tanks are fitted one behind the other in the wing centre-section, out-board of the engines; each forward tank holds approximately 180 gallons of fuel and each aft tank approximately 160 gallons. Integral tanks are embodied in the root of each outer wing and hold approximately 200 gallons apiece. Total usable fuel carried is just over 1,050 gallons.

From the three tanks on each side of the aircraft fuel is fed by gravity into a collector tank in each nacelle. There are no fuel cocks in the lines between main and collector tanks; three fuel-level valves in each collector tank control the flow from the three main tanks on each side.



Handley Page Dart Herald under construction at Woodley aerodrome

Each collector-tank has two submerged fuel pumps with external motors. They feed the fuel to the engines; one is for normal operation and the other is a standby. To avoid draining tanks when servicing the pumps, an isolating valve, fitted over the pump chamber at the bottom of the collector tank, can be closed.

From the submerged pumps fuel passes, via non-return valves and an electrically-controlled fuel-cock in each nacelle, to the low-pressure filter and flow-control unit on the engine. There is a cross-feed cock in the port nacelle.

HYDRAULICS AND ELECTRICS

The 3,000 lb. per sq. in. hydraulic system operates undercarriage, flaps, nosewheel steering and self-centring and the wheel brakes.

The system is supplied by two engine-driven pumps, one mounted on the accessory gearbox in each nacelle. System components are mounted on panels in the two nacelles; the supply, undercarriage and flap panels are in the port nacelle and the brake, brake-control and emergency panels in the starboard nacelle.

A separate hydraulic system, which includes a pump driven by an electric motor, is used for lowering the undercarriage and flaps if the main hydraulic system fails. An emergency accumulator stores energy sufficient for six full applications of the brakes.

Electrical power for aircraft services is provided by two 28-volt 6kw D. C. generators, a generator being driven by each engine. Three 24-volt 25 amp.-hour batteries are fitted to provide current for engine starting and, in case of emergency, to supply current to the essential and crash services. A fourth 24-volt 25 amp.-hour battery is carried for general services. A. C. current for certain instruments is provided by two inverters, with a third inverter as a standby.

The two D. C. generators give an ample margin of safety against failure, since the maximum load is within the overload capacity of only one of the two. Each can carry 25 per cent overload for ten minutes or a 50 per cent overload for five minutes.

If one generator fails, the other is capable of carrying all the essential and some of the non-essential services. If the second generator fails or a fault develops on the non-essential bus-bar, the essential services can be supplied by the standby batteries after the essential-services bus-bar has been split off from the rest of the general services.

As a safety feature, a single operation enables both generators to be isolated from the essential bus-bar which is then supplied from the batteries.

Each of two inverters supplies A. C. current to its own group of instruments. The supply to the fire-detector circuits is so arranged that, if the inverter supplying them fails, the remaining inverter is connected to the circuits.

A small separate battery for emergency use supplies the fire-extinguisher system and crash switches through an independent circuit.

FLYING CONTROLS

The dual flying controls are operated manually through steel tension rods, cables and chains or push-pull rods, except for the flaps, which are hydraulically operated through a system of cables.

Each aileron carries a spring tab which is controlled by a torsion-bar mechanism. The rudder incorporates a combined trim and spring tab operated through a torsion-bar mechanism and by a mechanical jack for trimming purposes. The port aileron incorporates a trim tab in addition to its spring tab. The elevator has trim, spring and servo tabs.

Hand-operated trim tabs are controlled by wheels on the centre control-pedestal in the cockpit.

A cable-operated flying-control locking system is fitted. It is controlled by a lever on the centre control-pedestal.

Flaps are cable-operated through two hydraulic jacks, one for each flap. They can be moved to three positions only - up, take-off and landing - and are mechanically interconnected for synchronisation.

DE-ICING AND FIRE PROTECTION

Protection against ice on the leading edges of the wings, fin and tailplane is by a hot-air system, fitted to the standard aircraft. A liquid system for the windscreen is also standard equipment. Electrical de-iceing is used for the propellers.

Hot air is supplied by two heat-exchangers, one in each nacelle. They are fed by the jet stream from the engine jet-pipe. Air drawn from an intake on the inboard side of the nacelle passes through the exchangers and is heated by the jet stream; it is then led, via light-weight ducting, to the wings and along the cabin roof to the tail unit.

Engine fires are smothered by discharging methyl bromide into the engine area. A single-shot system is used. On each engine there are three spray-rings, one 12 lb. bottle of methyl bromide and Firewire fire-detector units. A cross-feed, if fitted, effectively gives two-shot protection. Both bottles are discharged simultaneously by the operation of two inertia switches in the event of crash-landing.

PRESSURISATION

The cabin-air system of the Dart Herald maintains a pressure differential of 3.36 lb. per sq. in. between the passenger cabin and the outside air. This is equivalent to a cabin altitude of 6,300 ft. when the aircraft is flying at 15,000 ft.

Cabin internal temperature can be varied between 15°C. and 21°C. in a fully-furnished aircraft under stable cruising conditions above 10,000 ft., with the outside temperature varying from intercontinent maximum to minus 30°C.

This system also Provides more than 50 lb. of fre air per minute at 15,000 ft.

(Continued on page A.11)

THE ROTODYNE CONCEPTION

(By A Special Aviation Correspondent)

THE Rotodyne is a true V. T. O. Airliner. It ascends vertically in the same manner as a helicopter and, having gained height, flies forward as a fixed-wing airliner. By doing so it overcomes the speed limitations of the helicopter and dispenses with the long runways needed for fixed wing airliners.

Although there are today several thousand helicopters flying in all parts of the world, very few of these machines are being used for genuine commercial transport purposes. Those which are—chiefly in the U. S. A. and in Belgium—are heavily subsidized and in any case are operated on a relatively small scale and are not regarded as profit-making vehicles.

There are many reasons for this. Fundamentally, the helicopter is still in its infancy and the small machines which are commercially available cannot carry sufficient payload to bring in a worthwhile return. Nor is their range great enough for them to operate any but the most local of routes. Under all conditions of flight their propulsive efficiency is very poor; but, most important of all, inherent aerodynamic limitations imposed by the rotor preclude the possibility of satisfactory helicopter cruising flight at speeds greater than about 110—115 m. p. h.

The best helicopters cannot offer their occupants a "ride" as smooth or quiet as a modern airline passenger rightly expects. Admittedly the helicopter's ability to land close to city centres is no small convenience, but it is bought at a cost which, in the past, has been regarded as much too high to make such vehicles attractive for regular transport purposes.

The Rotodyne is not only the first aircraft whic really promises to overcome all these deficiencies it also enjoys certain additional advantages previousl denied to all rotary-wing flying machines.

In appearance the Rotodyne gives an impression o being a combination of helicopter and airliner; and in fact, it is both. It is much larger than an previous British rotary-wing machine, having fuselage big enough to accommodate 48 passenger or five tons of freight. It has two turbine engines giving adequate power for flight in complete safet with one engine stopped. And it has a fixed win and propellers in addition to its impressive four bladed 90 ft. dia. rotor. The reasons for this nove combination are best explained by outlining th manner in which the Rotodyne flies.

Each engine is a Napier Eland propeller turbin the power of the two engines together being som 7,000 horsepower. Before starting them, th Rotodyne pilot places the propellers in fine pitch, s that very little thrust is generated and minimur power absorbed. The propellers are mounted in th conventional manner on the front of each engine, bu at the rear of the engine is an auxiliary air compresso which takes in fresh air from above the wing. A the Elands run up to speed these compressors ar brought into action by means of a (type of) fluic drive clutch. The air from the compressors is ducte through large pipes along the inner part of the win and up to the hub of the rotor.

Here the air is fed past rotary seals and then int the blades themselves, through a trio of pipes leadin to pressure-jet units at the tips. These units opera like the combustion chamber of a jet engine. Th compressed air is mixed with kerosene (also fe

(Continued from page A.10)

through a pipe inside each blade) and the resulting combustion at the tip of each blade produces a forward thrust which drives the rotor round. This very direct method of driving a rotor has many advantages. In particular it eliminates the mechanical shafts and gears which would otherwise be needed—and which, to transmit several thousand horsepower, would be tremendously heavy.

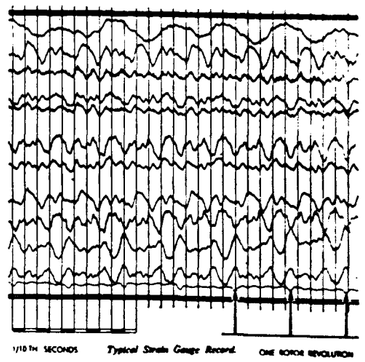
When the rotor is running at full speed the Rotodyne takes off vertically and climbs away as a helicopter, steering in the required direction by differentially altering the pitch of the propellers. As height is gained both propellers are gradually brought into forward positive pitch to accelerate the forward speed. At an appropriate height and speed the clutches are disengaged so that the air supply to the rotor dies away and the tip jet units are extinguished. Thus all the necessary engine power is transmitted to the propellers and the Rotodyne flies as a fixed-wing airliner, the rotor being left to "windmill" of its own accord.

As speed builds up the stub wing increasingly takes on the job of supporting the aircraft until, at the cruising speed of some 185 m. p. h. about 60 per cent of the lift is provided by the wing. The resulting "unloading" of the rotor removes the most critical of the aerodynamic restrictions and makes possible a speed approximately twice that of present helicopters. Moreover, the fact that the forward propulsion in accomplished by propellers and not by a rotor greatly increases the efficiency of the aircraft.

For landing the pilot merely goes through the same cycle of operations in reverse, finally letting down vertically with the rotor once more absorbing all the power.

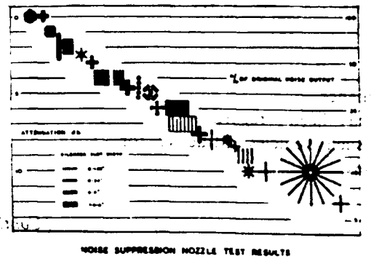
From the passenger's viewpoint there is little to distinguish the Rotodyne from a present-day airliner. It is sufficiently large and advanced in design to offer a completely comfortable ride, turbine power helping to reduce in-flight noise and vibration to a marked extent.

To a ground observer the Rotodyne does present a noise problem at the present stage of flight development. But intensive research work since 1952 has produced a silencing nozzle which will reduce the noise level to one-tenth of its present value. This, combined with the Rotodyne's rate-of-climb of over 1,500 ft./min. the highest in the world for a vertical



take-off aircraft—should ensure that not only is the noise level acceptable, but that it lasts for only a few seconds. In forward flight, with the tip jet burners closed down, the noise level is much lower than that of a Viscount. The noise suppressing nozzles are not yet fitted to the prototype Rotodyne but development of these devices is continuing concurrently on ground rigs.

Airline operators, as well as all kinds of other civil and military organizations, are watching the flight progress of the Rotodyne with extreme interest. In it they see the promise of an economical vehicle which can carry loads between the centres of cities, or along chains of islands, or across arduous and undeveloped territory, more rapidly than anything else yet developed by man.

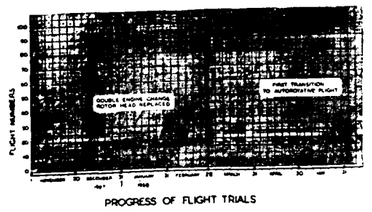


On the London-Paris route, for example, it is theoretically possible for a Rotodyne to take-off with a full load from a suitable side in the heart of London and alight in the center of Paris barely an hour later (at about the time that fixed-wing passengers would be arriving at London Airport).

The direct operating cost of such a flight would be not greatly different from that of a modern fixed-wing airliner plying between London Airport and Le Bourget.

There are numerous other routes over which the Rotodyne can show even greater advantages over any existing equipment. The west Indies abound with routes from 30 to 200 miles in length, across and between islands which at present are served only by surface vessels, or, in some cases, aircraft not very well suited to the task. Similar routes can be found in the East Indies, or between Melbourne and Tasmania or between the North and South Islands of New Zealand. Cars, passengers and general freight would welcome a Rotodyne service between Dover and Calais or across the Irish Sea—or, with unsubsidized fares, on the routes served by helicopters within the Low Countries and around the largest cities in the U. S. A.

Such services could be provided in any weather conditions acceptable to fixed wing aircraft since the Rotodyne can be equipped with every flying aid for navigation and blind-landing purposes.



FAIREY ROTODYNE

World's First Vertical Take-Off Airliner

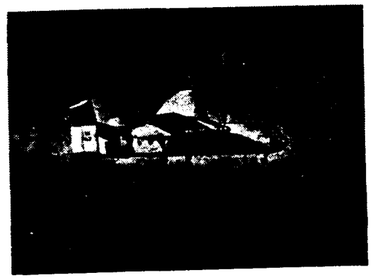
Cruising Speed	185 m. p. h.
Maximum Range	450 statute miles.
Maximum Payload	48 passengers or 12,000 lb. of freight or combined loads of cars, freight and passengers.
Specimen operations	48 passengers (or 9,000 lb. freight) at 185 m. p. h. over 200 statute miles. 34 passengers (or 7,000 lb. of freight) at 185 m. p. h. over 400 statute miles.
Specimen city-centre to city-centre times (take-off to touch down).	

London-Paris	1 hr.	20 min.
Paris-Brussels	1 hr.	2 ,,
London-Edinburgh	2 hr.	18 ,,
London-Manchester	1 hr.	10 ,,
London-Dublin	1 hr.	40 ,,
Athens-Istanbul	2 hr.	2 ,,
New York-Philadelphia	–	36 ,,
Philadelphia-Washington	–	45 ,,
Cleveland-Detroit	–	40 ,,
Wellington-Christchurch	1 hr.	12 ,,
Canberra-Sydney	1 hr.	–
Tokyo-Nagoya	1 hr.	2 ,,
Qubec-Ottawa	1 hr.	21 ,,

Operating cost	Approx. 4d. per passenger mile
All-up Weight	39,000 lb. (18 tons).
Fuselage—external length	58 ft. 8 in.
—internal cabin length	46 ft.
—internal cabin height	6 ft.
—internal cabin width	8 ft.
Wing span	46 ft. 6 in.
Rotor diameter	90 ft.
Height, overall	22 ft. 2 in.
Main power units	Two Napier Eland propeller turbines each of 3,500 e. h. p. (Early mark engines on prototype deliver 3,000 e. h. p.).
Rotor power units	Four Fairey Pressure Jets, each of 1,000 lb. thrust.
Propellers	13 ft. diameter, Rotol.

First Flight 6th November 1957

Pilot S/Ldr. Ronald Gellatly, A. F. C. Senior Helicopter Test Pilot. Second pilot—Lt. Cdr. John Morton.



Fairey Rotodyne, World's First Vertical Take Off Airliner.

The design and flight development of the Rotodyne have been the responsibility of a team led by Dr. G. S. Hislop, Ph. D., B. Sc. (Eng.), A. R. T. C., M. I. Mech. E., F. R. Ae. S., formerly Chief Designer (Helicopters) and now Chief Engineer (Aircraft).

Mr. F. H. Parker, A. F. R. Ae. S., the Engineering Manager, has led the team responsible for the manufacture and engineering development of the aircraft.

Overall direction of the project rests with Mr. R. L. Lickley, B. Sc., D. I. C., M. I. Mech. E., F. R. Ae. S., the Technical Director of the Company.

FLIGHT DEVELOPMENT OF THE ROTODYNE

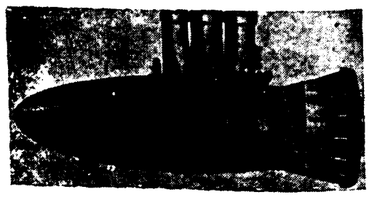
The Fairey Rotodyne is now well advanced on its flight development programme. Because it is the first and only aeroplane of its type anywhere in the world, much of the work entails research into fields never before explored outside a wind tunnel.

It first flew on 6th November 1957 and since then has made more than 80 flights. In the earliest stages each flight was of short duration—about 20 minutes—with the aircraft flying purely as a helicopter. Each sortie was concerned with a specific test which required careful analysis before the next step was taken on the road leading to transitional flight, speeds of over 150 m. p. h. being reached during this phase. On 10th April 1958 successful transition from helicopter to autogyro flight was achieved in straight, level and steady flight without any loss of height, and the Rotodyne flew forward on its two main engines alone, with the rotor power off. This achievement placed the Rotodyne far ahead of any other helicopter or vertical take-off aircraft in the world.

It is generally accepted that in the flight development of any aeroplane the number of flights made in a given period is a more valuable criterion than time spent in straight and level flight, and in this the Rotodyne compares very favourably with the Lockheed Electra, the new U. S. jet airliner. The Electra's 50 flights in the 3¼ months since its first flight are accepted in the U. S. as the most intensive programme ever carried out with a new aircraft.

The flight trails curve illustrates the way in which the Rotodyne's total was built up and explains any significant breaks in the programme. The curve illustrates that apart from the delay inseparable from an engine change and planned inspection, steady progress has been made with an excellent record of serviceability.

Photo illustrates the way in which speed has been increased as the trials proceed. The general approach is to clear structural integrity and flight handling before each increase in speed. While conservative in the early stages, this is the only possible approach on an aircraft incorporating unique design features. The autogyro phase now in its early stages has even now led to still higher speeds being achieved.



Fairey Rotodyne Tip-Jet Unit Fitted with Experimental Silencer.

HANDLING

From the outset, the cyclic and collective pitch controls were found to be extremely crisp and precise (Fairey power controls are used with duplicate sources of hydraulic power). The temporary fixed undercarriage makes it necessary to land the aircraft with vertical velocities not exceeding 3 ft. sec. The

fact that this has presented no difficulty illustrates the excellence of these major flying controls.

Behaviour of the rudders and elevators at forward speed has been satisfactory, the elevators in particular giving a powerful control of fuselage attitude.

The Wind Tunnel tests had indicated that only small longitudinal trim changes should occur as the aircraft gains forward speed from the hover or moves out of the ground cushion. Flight experience proved this to be true.

VIBRATION LEVEL

In general the passenger cabin vibrations are of small amplitude, the level decreasing at the higher speeds as the rotor power and collective pitch decreases.

Flight Test Instrumentation installed in the Rotodyne.

NOISE

A considerable development effort has been devoted to the suppression of the noise from the tip-jet units. This noise is of course, only a problem during take-off and landing since in normal cruising flight, these units are shut off and the aircraft is very quiet indeed.

The investigations have been successful and various experimental silencers have been tested with very promising results. The final design of the noise suppression nozzle is now being developed on rigs at White Waltham.

The Company has every expectation that when the silencers have been fully developed the aircraft will gain complete public acceptance from the noise aspect.

PERFORMANCE

Comprehensive performance tests have not yet been carried out though present indications are that hovering performance and vertical climb are considerably better than had been predicted. The following figures represent the figures so far reached with the present prototype :

Vertical rate of climb	— 1,300 ft./main at partial power
Level speed	— 155 m. p. h. at partial power
Forward climb	— 2,400 ft./min. at partial power
Maximum altitude	— 7,000 ft.
Maximum flying weight	— 33,500 lb. (Design A. U. W. of prototype with existing engines = 33,000 lb.)

INSTRUMENTATION

The instrumentation installed in the prototype is extremely comprehensive. Three auto-observer panels are fitted, the essential instruments being monitored by human observers. In addition several hundred strain gauges are fitted, both to the rotor and to the airframe, rotor gauge indications being transferred to the fuselage recorders via slip rings. The excellent results obtained are illustrated on the typical strain gauge record enclosed. This may fairly be considered to represent a triumph in itself.

STRUCTURAL TESTS

Following initial flights at low speed the cruising speed was increased step by step to the present value of 155 m. p. h. At each stage comprehensive strain gauge measurements were made to assess the

Vibration Tests on the Rotodyne.

magnitude of fluctuating stresses, blade flapping angles, clearance from droop stops, airframe vibration levels and so on. The measured fluctuating stresses are compared with the results achieved in the laboratory fatigue tests, to ensure that adequate safety standards are maintained.

PRE-FLIGHT TESTING IN THE WIND TUNNEL

The extensive programme of tunnel testing made possible an accurate assessment of the stability of the aircraft and control effectiveness, as well as permitting a comprehensive prediction of the trim and manoeuvre configuration of the aircraft with variation of forward speed, rotational speed, etc. This is used to give the pilot a realistic guide as he extends the flight envelope in the course of development.

Static Rig for the Rotodyne at Boscombe Down.

These tests confirmed that the changes in trim due to rotor airframe interference were small and well within available control, and that the loss of lift due to rotor downwash on the airframe at low forward speeds was also quite small.

GROUND RESONANCE PROBLEM

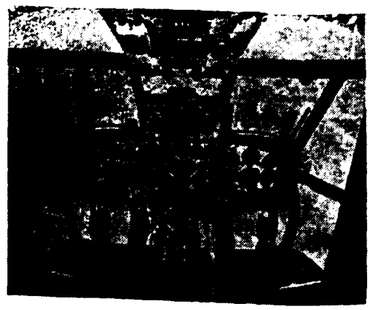
A 1/15th scale dynamic model was built to be used in conjunction with the theoretical work on the ground resonance problem. The model reproduced the stiffnesses and inertias of the blades, air-frame and undercarriage—though not of course the aerodynamic characteristics of the blades. Extensive tests were made to check the behaviour of the model and also to correlate theory with experimental results. At a later stage the actual prototype was subjected to tests designed to measure the distribution of stiffness and damping available.

To carry out these full scale tests, the rotor head and blades were removed and replaced by an equivalent mass. A rotating out of balance force was then fed in at the head, and airframe response at all critical points measured over a range of frequencies from 0.5 to 3 cycles/sec. In order to simulate the effect of lift the complete airframe was slung to a jib and varying lift forces up to the aircraft weight applied while the tests were in progress. The very low frequencies involved made it necessary to apply the lift force through air jacks to give a soft suspension.

The test information was fed back into the model tests and a complete ground resonance picture obtained. It became evident that among the various modes of vibration, a rather unusual combination of circumstances existed in which the aircraft might encounter ground resonance. While a new retractable undercarriage was being designed to avoid this trouble, the original design was fixed temporarily in the down position using rigid bracing struts so as not to delay initial flight testing. The value of these intensive pre-flight tests became evident when the final full scale ground resonance and complete power plant clearance tests were accomplished successfully in five days.

TIP JET SYSTEM

The units for the tip jet system were developed on static rigs at White Waltham airfield. After static trials, tests were made on a rotating single blade rig which reproduces centrifugal effects on air flow and fuel flow. The main problems concerned stability over a wide operating range, light up and maintenance of high combustion efficiency. The development is of an empirical nature requiring an extensive test effort.



Rotodyne Cockpit.

The final approval of the units was carried out in a 25 hour endurance test on the complete four blade rig at Boscombe Down.

BOSCOMBE DOWN RIG

Certain features are essential to the basic safety of the aircraft. These comprise head and blades, hydraulic controls, the complete power installation, air ducting system and tip jet units, together with associated operating controls. So great is the importance of these assemblies that a special rig was built at Boscombe Down incorporating all of them, full scale.

This rig has proved invaluable; the tip jets took their final approval test on it together with the rotating seals at the head; the mechanical reliability of the head itself including bearings, hinges, control etc. was established for an initial safe life; engines and propellers, together with their special controls, were subjected to careful functioning tests; and the control cabin was laid out in the same pattern as the aircraft so that the pilot became thoroughly familiar with control positions and the operating techniques required. In this respect, the rig corresponds almost to a flight simulator.

HEAD & CONTROLS

Apart from the major rig at Boscombe Down, a separate installation has been built at the Hayes factory to test the swash plate mechanism and the hydraulic jacks. The rig was used to clear these items for an initial safe life and is now continuing with an endurance test.

FATIGUE TESTS

Orthodox fatigue tests on airframe components were carried out in a Losen Hausen machine which subjects the specimens to carefully controlled oscillating stresses. In addition, blade specimens were subjected to fatigue tests in special rigs. Simulated centrifugal forces were applied by internal struts, the specimens being freely supported and subjected to oscillations at their own natural frequency. These tests are continuing.

PRE-FLIGHT TRIALS OF COMPLETE AIRCRAFT

The aircraft with temporary fixed undercarriage began its ground resonance trials on 25th October, 1957. These were completed satisfactorily and were followed by the final functional checks of the complete power plant and control system. This vitally important phase of testing was completed by 3rd November 1957, and the Rotodyne flow three days later.

These pre-flight trials and tests with models, ground rigs and then the complete aircraft and its equipment, were the most exhaustive ever given a new British aeroplane. Their value is reflected in the fact that ground trials were completed in only 12 days, and in the Rotodyne flight record in the succeeding six months.

BRASS AND COPPER WARE INTERESTS MEET

The two-day conference of manufacturers, dealers and exporters of brass and copper ware, which concluded in New Delhi on 12—8—58 has recommended that model rules should be drawn up for setting up voluntary organisations for promoting healthy business practices, welfare of the craftsmen and improvement of quality of the products.

The conference, which was convened by the all-India Handicrafts Board, was attended by representatives of the two crafts from Delhi, Bombay, Jaipur, Moradabad, Varanasi, Tanjore and Kumbakonam.

An official press release said that it was decided that the model rules should be drawn up by Government and circulated to representatives of the trade.

The question of export of brass and copper ware was examined by the conference. The conference was of the view that while the exports had shown an upward trend, efforts should be made to maintain the trend. It was necessary that unhealthy competition among exporting firms should be avoided. Particular attention should be paid to quality.

The difficulties faced by the industry in securing raw materials at reasonable prices were discussed and it was decided to study the question further. Technical production problems of the industry as well as packing, design, credit facilities and marketing were also discussed.

Handley Page Dart Herald - Loss of First Prototype Serious Engine Failure Followed by Fire

By Public Relations Officer — HANDLEY PAGE LTD. U. K.

IN connection with the loss of one of its Dart Herald prototypes en route to the Farnborough Air Show from Woodley aerodrome on the 30th August, Handley Page Ltd. (in consultation with Rolls-Royce Ltd.) makes the following announcement :

While flying a Dart Herald at 6,000 feet, Squadron Leader H. G. Hazelden, Handley Page's chief test pilot, heard a loud bang. This was caused by the serious failure of the aircraft's starboard Dart prop-jet engine. Parts of the engine were thrown through the engine casing and damaged the fuel lines. An uncontrollable and catastrophic fire ensued.

Squadron Leader Hazelden brought the burning aircraft rapidly to earth and, by superb airmanship, landed it safely in a small field. All on board were able to disembark unhurt before the aircraft burnt itself out.

During the last stage of the Herald's flight, its burning starboard engine came adrift from the wing and fell to the ground three miles from where the aircraft landed—the engine bearers having burnt through. Although this wing was also on fire, the fail-safe qualities of its construction prevented a structural failure. So intense was the fire that flames swept aft along the length of the fuselage and burnt off part of the starboard tailplane; it fell to the ground about a mile from where the aircraft landed.

Despite the loss of one engine—and its power—the loss of part of the tailplane and despite the wing being seriously afire, the Herald remained controllable throughout the four to five minutes in which it was brought expertly and safely to the ground. This says much not only for its pilot's skill but also for the aircraft's design and robust construction; it will stand it in good stead for the rigorous operation for which it has been built on the world's branchline routes.

This prototype Dart Herald had finished its flying trials—more than 200 hours in the air—since it made its maiden flight some four months ago. Apart from one or two tests, it had satisfactorily completed everything necessary to enable a certificate of air worthiness to be granted to it. This loss, although regrettable, will in no way influence the aircraft's production programme which is well advanced. A second Dart Herald prototype will be flying within the next few weeks.

AMAR DYE-CHEM

Mr. A. K. Doshi, Chairman of the Amar Dye-Chem Ltd. told the share-holders at the fourth annual general meeting in Bombay that the company had to find more money as its requirements of capital were not yet fully met. Although the internal resources would increase over the next few years, those would not suffice for the purpose of expansion. He, however, pointed out that the immediate needs would be met from loans from banks and largely from managing agents and their associates.

Mr. Doshi welcomed the proposal to export dyestuffs but pointed out that the greatest hitch was the high manufacturing costs of Indian products. He felt that raw materials and heavy chemicals should be made cheaper to the dyestuffs industry. The company, he stated, had, however, effected a shipment of its products to China and also secured some trial orders from Europe.

Mr. Doshi hoped to produce BON acid soon after the heating machine was installed. If the process for which the plant had been designed became successful, it would contribute to the economic working of the company, besides saving a good deal of foreign exchange, he added.

Yet Another Achievement of Hindustan Aircraft Factory

"PUSHPAK", Ultralight Two-seater Aircraft Produced

THE Hindustan Aircraft Factory, Bangalore, has developed a new type of 2-seater aircraft "PUSHPAK", marking yet another milestone in India's progress in Aviation.

The new aircraft was built within six weeks, a remarkably short period for the production of an aircraft, and is powered by an American Aero-engine. Very soon an Aero-engine manufactured in the country will be fitted to it.

Shortly before the announcement, the Chief Test Pilot of the Hindustan Aircraft Factory, Flt/Lt. K. Bhargava gave a demonstration flight in the new aircraft which was witnessed by local Pressmen and other prominent citizens.

"Pushpak" can be used for communication duties with the Army, Navy & Airforce. It is suitable for artillery observation work and also fulfils the demand of civil operators who need such type of plane owing to recent import restrictions.

"Pushpak" costs just about Rs. 20,000 and will be ideal for flying clubs particularly for training cadets in the air wing of the National Cadet Corps, for pleasure flights and for short-distance communications. In view of the low cost for an aircraft of this type, it will be within the reach of many private owners.

The new aircraft can also be used by State Governments for transporting police squads, making aerial surveys and meeting emergencies like floods, forest fires, etc., and for control operations connected with elimination of weed, pests, malaria and other epidemics.

The cruising speed of the new aircraft is about 90 miles per hour and has an endurance just over three hours.

India's Defence Minister, Shri V. K. Krishna Menon evinced personal interest in the production of "Pushpak" and visited the Hindustan Aircraft Factory twice while under construction.

The factory will also manage to supply low-priced hangars for accommodating "Pushpak".

According to the Hindustan Aircraft authorities mass production of "Pushpak" will depend upon several factors such as the nature and volume of demand, availability of raw materials for the construction, etc.

Aero-Engine News

From the S. B. A. C. comes more encouraging news about the cash value of British aero-engines now being exported. During the first four months of this year the average weekly income from overseas orders in this category was no less than £ 900,000. This is certainly a remarkable increase over the corresponding figures for previous years— £ 376,000 in 1955, £ 511,000 in 1956, and £ 688,000 in 1957. Indeed, as the S. B. A. C. points out, the day when British aero-engines will be earning a million pounds sterling in the export markets every week cannot be far away.

During the four months under review (from January to April) the total aero-engine export value was no less than £ 15.5 million. This represents an annual earning rate of £ 46.5 million which compares very favourably indeed with the record figure of £ 40.6 million attained in 1957. If this new annual total eventually materializes for 1958, it will be more than double the annual totals of 1953-55 inclusive and will represent a fivefold increase of the 1951 and 1952 totals.

Other British aero-engine news last week came from Bristol Aero-Engines, Ltd., who announced that their Olympus 201—or B. Ol.7—had successfully completed an official type test at a thrust rating of 17,000 lb. Previously, the highest official Olympus thrust was 16,000 lb.—for the B. Ol. 6. These two engines are externally similar but differ in some internal respect

(Continued on page A.21)

New Electronically Controlled Machine Tool to Speed Aircraft Production

Three-Dimensional Miller 30 Times Faster Than Prevailing Systems

A new 50-ton electronically-controlled machine tool is now operating in Britain which can produce machined integral aircraft components up to 30 times faster than any prevailing system or method in Europe.

Known as the Fairey/Ferranti Three-Dimensional High-Speed Miller it is one of the most advanced machine tools in the world. By milling large aircraft components direct from slabs of light alloy it will speed aircraft production and lighten structural weight.

It was designed and built by The Fairey Aviation Co. Ltd. in conjunction with Ferranti Ltd., Edinburgh, and is operating at the Fairey works at Heaton Chapel, Stockport, Cheshire.

The 3-D Miller has a table capacity 8 ft. high and 28 ft. long and machines slab material at speeds of up to 150 inches a minute.

The conception of the machine is the result of the demand in modern aircraft design for more speed, less weight and cleaner outlines. To achieve these ends the trend has been towards integral construction —changing from multi-component structures with rivetted and bolted assemblies to single piece major components.

Aircraft manufacturers in the United States began producing such components from light-alloy forgings of unprecedented size and preparations were made for the installation of heavy forging presses.

The performance of the first presses soon brought to light the severe limitations of forgings and these, combined with the enormous capital outlay necessary for heavy presses, led British aircraft manufacturers to examine slab machining techniques. Investigations in Europe and the U. S. A. soon made it quite clear that existing machine tools were inadequate for aircraft manufacturing requirements and The Fairey Aviation Company started design of the 3-D Miller using as a basis the Ferranti method of control by electronic computer. A design and development contract was issued by the Aircraft Production Development Directorate of the Ministry of Supply in late 1955 on The Fairey Aviation Company.

(Continued from page A.20)

that have not been revealed to date on the grounds of security. Bristols claim that as a result of its recent achievement, the B. Ol. 7 has the highest thrust/weight ratio of any current high-thrust engine that has been type tested.

Bristol Aero-Engines have also announced that they have received another order from Japan for Orpheus turbojets. These will be used to power further examples of the Japanese Fuji basic jet trainer.

* * *

R.O.C. JUBILEE

Some 300 members of No. 5 (Watford) Group of the Royal Observer Corps attended a dinner in the Queen's Building restaurant at London Airport on June 7, to celebrate the Silver Jubilee of the Group's formation in 1933. No more appropriate place could have been chosen, because the Airport is within No. 5 Group's area of responsibility, while its present Commandant, Obs. Cdr. G. A. D. Bourne, is both R. O. C Liaison Officer at the Airport and Manager of the Airport Branch of Barclays Bank.

After dinner, the toast to the Royal Observer Corps was proposed by the Airport Commandant, Mr. G. J. H. Jeffs, who said that he was an old friend of the Corps, having been a controller at Fighter Command H.Q. before and during the Battle of Britain in 1940. He added that he was always pleased to welcome officially organized parties of observers at the Airport and to let them see the radar rooms and other places not normally open to the public—all of which should be good for the present recruiting campaign!

BOARD OF EDITORS

(HONY.* MEMBERS)

Representatives Abroad :—

Representatives in India :—

Edited and published by T. S. Nagaraja Rao, for JOURNAL OF INDUSTRIAL ENGINEERING, 62, Jayprakashnagar, Goregaon, Bombay, and Printed by T. S. Gopal Row, at M. K. Press, Tanjore.