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RECENT ACTIVITIES IN THE EXPLOSIVES INDUSTRY

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It was on the 24th of October, 1953 that I, as spokesman for the Industrial Explosives Society of Japan, made a speech on the subject of the "Recent Activities in the Explosives Industry in Japan" on the occasion of commemorating the seventy-fifth anniversary of the founding of the Chemical Society of Japan.

Only some fifteen years have elapsed since the industrial Explosives Society was founded, but the explosives industry in this country has a history of over one hundred years. In the days when the Chemical Society was instituted, the explosives industry, had already become one of the most important industries in the country, and the plants had kept on enlarging and multiplying year after year to meet the military and civil demands. In the wartime of 1941-1945, the annual output of propellants and high explosives amounted to about 100,000 tons and that of industrial explosives to about 45,000 tons.

As a result of the defeat in war, Japan was compelled to close all the explosives factories, both for the Army and the Navy, that were located at various places. With the termination of the war, the industries that require explosives came to a deadlock, the production of industrial explosives having dwindled to 600 tons for the period of August to December 1945. Owing to the increased demand for coal and pyrite ore in the country however, the explosives factories resumed their activities in the first half of 1946.

According to the instructions issued by occupation army explosives in this country were to be produced and consumed with the authorization from the GHQ. This was quite a matter of course in occupied Japan, but certain rumours were circulated which, if they were true, would have been a serious cause for uneasiness to explosives manufacturers. It was rumoured that GHQ had discussed repeatedly on the question of controlling the explosives industay in Japan; that it was asserted by some that the demand for explosives in Japan being hardly more than two or three per cent of the output in U. S. A., it would be better to close explosives factories in this country, the demand here being met by imports from the United States of America. Others, however, it was rumoured, were opposed to the view, holding that industrial explosives factories should be permitted to operate for civil purposes, because there would be little possibility of their producing military explosives. If the former view should prevail, the explosives industry in Japan would naturally be suspended

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in its activities for at least four or five years which would bring irreparably disastrous consequence to the industry.

At the end of 1945, GHQ gave permission to Japanese manufacturers to produce industrial explosives, but it should be remembered that the Potsdam Declaration allowed Japan to maintain her industries on the production level of the years 1930—1934. The actual output of the explosives industry in those years were as follows:

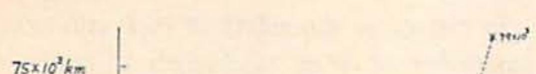
	Explosives (Unit: ton)	Blasting caps (10,000 pcs.)	Safety fuse (km)
1930	4,918	5,156	39,550
1931	4,134	5,110	29,470
1932	5,955	6,568	30,860
1933	10,144	7,337	39,250
1934	13,523	12,036	58,790
Average	7,735	7,241	39,584

The demand in 1946 exceeded the figures shown above. When the Institute of Explosives Manufacturers made a petition to GHQ for the production of explosives for the current year, the officer in charge of the matter at GHQ proposed to shut down one dynamite factory either at Asa or at Nobeoka and to abolish production of "carlit", the same not being wanted for civil purposes. This proposal of GHQ so unexpectedly made gave a great shock to the persons who had great interest and concern in the explosives production. The Institute again petitioned GHQ that a thoroughgoing inquiry should be made as to the actual conditions prevailing in each factory in those days. The petition was granted by GHQ, and the investigation committee was formulated. The committee, after a careful and exhaustive survey for a period of three months, submitted its report on the facilities and capacities of all explosives factories. When the report was submitted to GHQ it was approved and in consequence of which GHQ complied with the request of the Institute of Explosives Manufacturers. The items, number of factories, and quantity of output authorized by GHQ were as follows:—

Items	Number of factories		Quantity
Gelatine dynamite	3	(annually)	7,862 tons
Powdery dynamite	3		5,262
Ammonium nitrate explos.	2		3,565
Carlit	1		2,574
		(Total).........	(19,263)
Gun powder	1		675
Safety fuse	7		78,600 km.
Blasting caps	4		105,100,000
Electric detonators	6		33,350,000

(The following factories were ordered to be shut down: 1 carlit factory, 1 safety fuse factory, 1 blasting caps factory, and 2 electric detonator factories.)

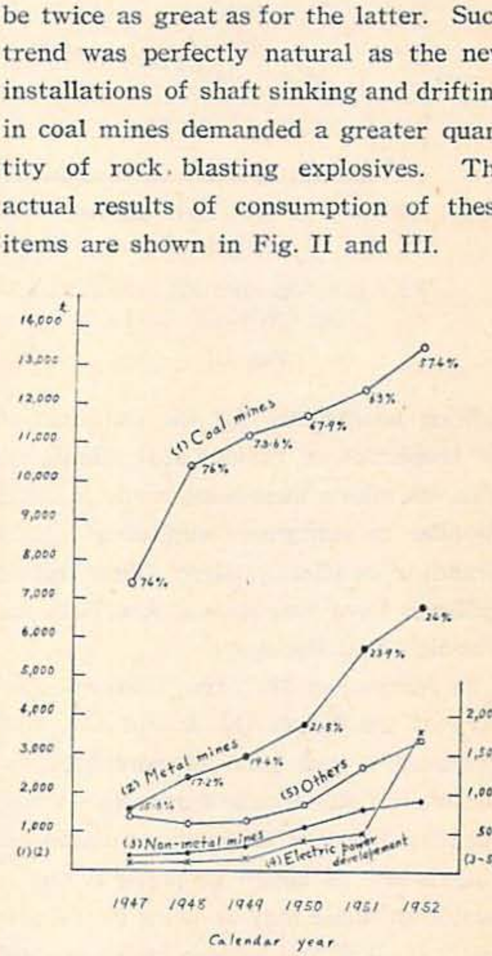
Since then, with the increase of demand, it was necessary to enlarge the facilities of each factory and also to re-open the closed factories. In this connection, the Sunagawa Factory of the Hokuyo Kayaku K. K. which had been established in wartime was given permission by GHQ to operate the said factory in 1950. Consequently the production of industrial explosives from 1946 to 1952 is as shown in the following diagram.



ANNUAL PRODUCTION OF BLASTNG EXPLOSIVES & BLASTING ACCESSORIES

Fig. I.

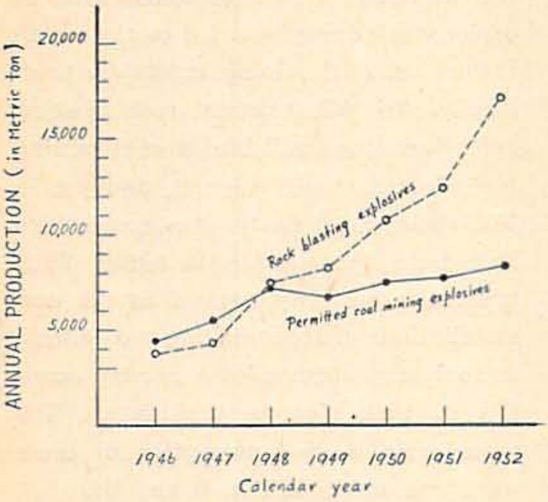
As industrial explosives are not capable of being stored for an indefinite duration of time, annual output of this sort of explosives is fairly well balanced with the amount of consumption, the figures of production being naturally the figures for consumption. In the past, the demands for rock blasting explosives and coal mining explosives have, in general, stood on the ratio of two to one. For some time after the end of the war, however, public works in this country were still meagre, nor metal mines had revived in their working. Under such circumstances explosives industry was led to the manufacture of coal mining explosives principally. In 1948, however, rock blasting explosives stood well beside coal mining explosives in their demand, and yet in 1952 the demand for the former came to be twice as great as for the latter. Such trend was perfectly natural as the new installations of shaft sinking and drifting in coal mines demanded a greater quantity of rock blasting explosives. The actual results of consumption of these items are shown in Fig. II and III.



FIELD OF CONSUMPTION OF EXPLOSIVES

Fig. II

As will be seen from statements above, industrial explosives in this country, after the war, were chiefly consumed in coal mines, and the investigations, therefore, were concentrated on that field. Manufacturers of industrial explosives have built laboratoires with various kinds of



ROCK BLASTING EXPLOSIVES vs. PERMITTED COAL MINING EXPLOSIVES

Fig. III

testing equipments for the examination of properties of various coal mining explosives, efforts were being made in order to offer to consumers explosives of new brands of excellent quality. Thus testing galleries have been built at Asa, Nobeoka, Shiroishi and Hodogaya.

In Autumn of 1947, the Taketoyo Factory of the Nihon Oil & Fat Co., Ltd. produced a new kind of permitted explosive — Toku-Shoan-dynamite — which contains powdery seaweeds as flame extinguisher. Although its power to reduce explosion flame may be owing to the presence of alkali and halogen atoms or ions, aside from any theoretical discussions, the new explosive is undoubtedly a noteworthy invention. Again, at the Nobeoka Factory of the Asahi Chem. Ind. Ltd., a low density ammonia dynamite has been newly deviced by the use of bulk and porous crystals of ammonium nitrate and sodium chloride. This licensed explosive is known as LD-Shōan dynamite. SS-Shōan dynamite, another super-safety dynamite, maufactured at the Asa Factory of the Nihon Kayaku K. K. contains much proportion of inert substances, such as talc powder besides ordinary cooling salts. New sheathed explosives produced at Taketoyo Factory also is a contribution to greater safety of coal mining operation.

In regard to the safety of coal mining explosives or firing mechanism of methane-air or coal dust-air mixtures, innumerable papers have been made public. It is now considered that the ignition of methane is not caused by molecular reaction by heating, but it owes to the formation of propagation centres of chain carriers. To break the chain of reaction reducers or cooling salts are added to the explosive compositions. Dr. T. Murata and his collaborators have examined the effects of flame extinguishers as an experiment and were confirmed of their knowledge as the oxygen balance between reducing substance and explosive components. The experiments have also clarified that the concentration of reflected shock is the efficient cause for igniting methane. Alkali halides have remarkable effort for restraining coal-dust explosion, while halogen ions themselves have not so much to do with methane ignition. These facts have independently been proved by Prof. R. Goto of the University of Kyoto, Prof. T. Hikita of the University of Tokyo, Prof. G. Yoshida of the Kyushu Institute of Technology and Dr. N. Fusamura of the Waseda University.

In 1947, the burn cut method of blasting was introduced by an American Mining Inspector who was stationed in Kyushu Area. The method is now extensively employed not only in Kyushu but also all over Japan where coal mines are, proving itself of great practical value. Prior to this, at Kamioka Mine, the burn cut method had been in use as an experiment, and the introduction of the method by an American inspector put spurs to further research on the method. In summer of 1949, the Blasting Research Committee-a committee elected and appointed jointly by the Japan Mining Association and the Japan Explosives Manufacturers Institute-carried out its field experiment lasting for a week and obtained basic conception on the working of the method. In those days Dr. K. Hino and the late Mr. J. Sato also carried out tests a number of times and established an experimental formula of burn cut blasting system. On the other hand, there have lately appeared many excellent reports on the studies of blasting, such as "Fundamental Experiments" by Dr. Y. Shimomura, "Graphical Solutions" by the late Coronel H. Kobayashi and the "Slabbing Theory" by Dr. K. Hino.

Industrial explosives in this country contain much ammonium nitrate, an amount of about 65% of the total quantity of the ingredients. Ammonium nitrate decomposes explosively, liberates large amount of gaseous products and puts forth formidable power. Moreover, because of its low explosion temperature it is indispensable for safety conponent of coal mining explosives. But owing to its hygroscopic property and the presence of many transition points, ammonium nitrate is deliquescent and easily solidifies. Dr. K. Hino explained its hygroscopic property by means of a new hypothesis of molecular construction, and contributed much toward amelioration of damp-prevention. Mr. T. Sawada observed that when ammonium nitrate is mixed with other salts the transition temperatures disappear from the ordinary positions, and that in the presence of potassium salts the transition point between phase III and IV disappears. Ammonium nitrate, therefore, can be kept from caking by adding potassium nitrate. Crystal structure of ammonium nitrate in all its phases is clearly explained by Mr. I. Fukuyama who worked under the direction of Prof. K. Tanaka of the Uuniversity Kyoto. His examinations also showed very precisely that the soldification is caused by the small amount of water content adhered to ammonium nitrate crystals. Dr. T. Murata and Mr. T. Sakurai made attempt at mixing nitroglycerin dynamite compositions with arum-root powder or vinyl acetate containing water to give plastic behaviours to them. These are indeed water-containing dynamites of surprising idea, and it is an amazing fact that water contained is no obstruction to its explosive property.

The production of blasing caps has been mechanized by the efforts of Mr. M. Yamada and his collaborators. They are now planning automatically working machinery to produce electric blasting caps. "Study on Blasting Caps" by Mr. T. Mataki and "On Electric Blasting Caps" by Mr. K. Okazaki are very valuable papers on manufacturing blasting accessories.

Millisecond delay detonators have been recommended in numerous research papers and in catalogues of manufacturers for 1947—1948, but so far they not been imported into this country. As these delay detonators have many advantages and give benefits to blasting work, the demand for them has been rapidly increasing, and the time of their mass production will not be long to come as the manufacturers are making the best of their effort for the purpose. In connetion with the problem Mr. S. Wakagi's war-time studies on "fumeless combustion powder train" have made much towards advancing the investigation. Combustion among solid substances is now being studied by Mr. Y. Wakasono, Mr. H. Osada, Prof. T. Hikita and a few other investigators.

In late years, more than fifty papers are being published annually in Japan devoted to the study of explosives. Beesides those I have already mentioned, the following are the chief and valuable publications. Prof. T. Hikita and Prof. T. Kihara have succeeded in establishing an equation relative to the state of gas at high temperature and high pressure, and tried to develop the theory of detonation mathematically. Mr. T. Ōkawa and collaborators have taken highspeed photographs of detonation flame, demolition of concrete blocks and the scenes of blastng coal and limestone. These photographs are of great value for analyzing detonation of explosives as well as demolition of rock and coal. Prof. H. Sudō and Mr. T. Uemura are also making observations on detonation phenomena by the use of instantaneous photography. Explosion accidents coming from potassium chlorate are matters for investigation and study in order to discover their causes, and yet we have explored so little in that area. Mr. T. Asaba has been eagerly keeping up his experiments to explain the structure of explosive decomposition of chlorate mixtures. Mr. T. Jinda has been endeavouring to detect and ascertain and also analyze poisonous gas generated in course of blasting. Although his study is far from being pretentious, yet when viewed from the point of public health it is nonetheless of grave importance.

ERRATA:— In Fig. I, the unit of balasting caps which is expressed by $\times 10^8$ should be read $\times 10^7$