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Metallurgical Dust Collection in the Open Hearth and the Sinter Plant

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INTRODUCTION

THE Hamilton Works of The Steel Company of Canada is a fully integrated steel plant with an annual capacity of three million tons. Located on the south shore of Hamilton bay, it is in the centre of Hamilton's industrial belt. The heavy concentration of industrial activities found in this area, accompanied by other well-known sources of pollution which are normal to urban areas, is creating a pollution problem which concerns both industry and the general public. The Steel Company of Canada has recognized this problem and, accordingly, has adopted the policy of integrating suitable pollution control devices into its new installations. Much effort is also being expended to control the emissions of air contaminants from the existing equipment.

At the Hamilton Works, there are two main sources of metallurgical dust emissions to the atmosphere — the Open Hearth furnaces and the Sinter Plant. Of these two, the Open Hearth furnaces are, undoubtedly, the largest single source of dust emissions which are still uncontrolled. Although some progress has already been made, it is in this area that the steel industry must, in the near future, expend a great deal of time, ability and money in order to achieve control of air pollution.

This paper will consist of two parts. Part I will deal with the cleaning of dust-laden gases exhausted from an open hearth furnace. Part II will review the pollution arresting equipment in a sinter plant.

THE OPEN HEARTH

The Hamilton Works has two Open Hearth shops, with a total of fourteen furnaces. No. 2 Shop consists of nine medium-capacity furnaces, and No. 3 Shop has five larger units equipped with oxygen lancing facilities. It was in No. 3 Shop that an electrostatic precipitator, collecting 35 tons of dust daily, was recently installed on No. 35 Furnace. This furnace, completed in 1961, is one of the largest of its kind in existence. This 500-ton-capacity furnace has a designed fuel rate of 3,000 (U.S.) g.p.h. The practice of introducing oxygen into the furnace at an unprecedented rate is subjecting the precipitator to extreme dust loads. The performance data obtained from this unit, under such conditions, will serve as the design criteria for future precipitators to be erected on our Open Hearth furnaces.

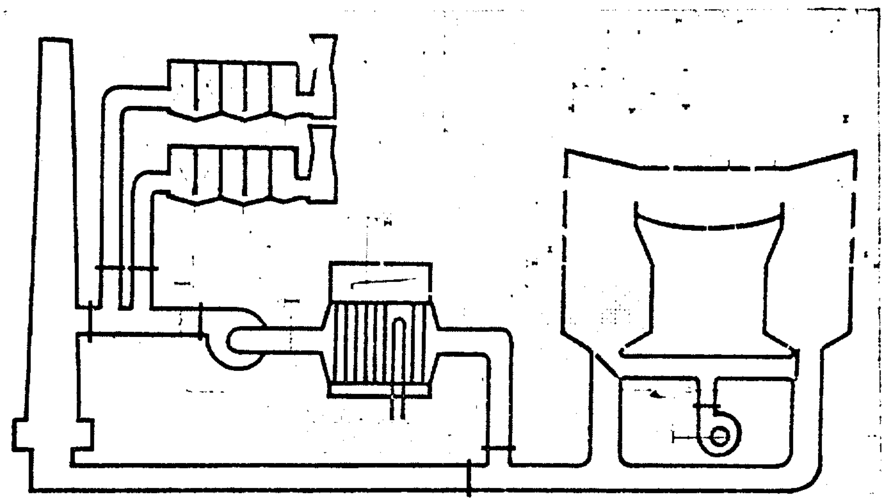

Figure 1.—Line diagram of the Open Hearth System: forced draft fan, checkers, furnace, flues, waste heat boiler, induced draft fan and precipitators.

It would be appropriate to describe briefly the physical structure of the open hearth system (Figure 1), including a note on its operation. The system includes a forced draft fan, checkers or heat regenerators, slag units, suitable waste gas conducting flues, a waste heat boiler (Figures 2, 3, 4 and 5), an induced draft fan (Figure 6), and, on No. 35 Furnace, an electrostatic precipitator (Figure 7). The checkers, the furnace, the slag pits and the flues are built and lined with refractory brick (Figures 8, 9 and 10). Due to the fact that the furnace is alternately fired from each end, it is necessary to duplicate the fuel and burner system, the checkers and the slag pits. The furnace is reversed at regular intervals so that the air for combustion is preheated by one set of checkers while the other set absorbs the heat from the waste gases.

The primary function of the open hearth furnace is to reduce the carbon content of the molten bath to a predetermined level and to remove certain impurities, such as sulphur and phosphorous, which are present in varying concentrations. This operation is a batch-type process, with each batch called a heat. The average duration of a heat, on No. 35 Furnace, varies from four to six hours. The heat cycle consists of the following periods:

(1) *Charging Period* — during which limestone, iron ore and heavy scrap are charged into the furnace.

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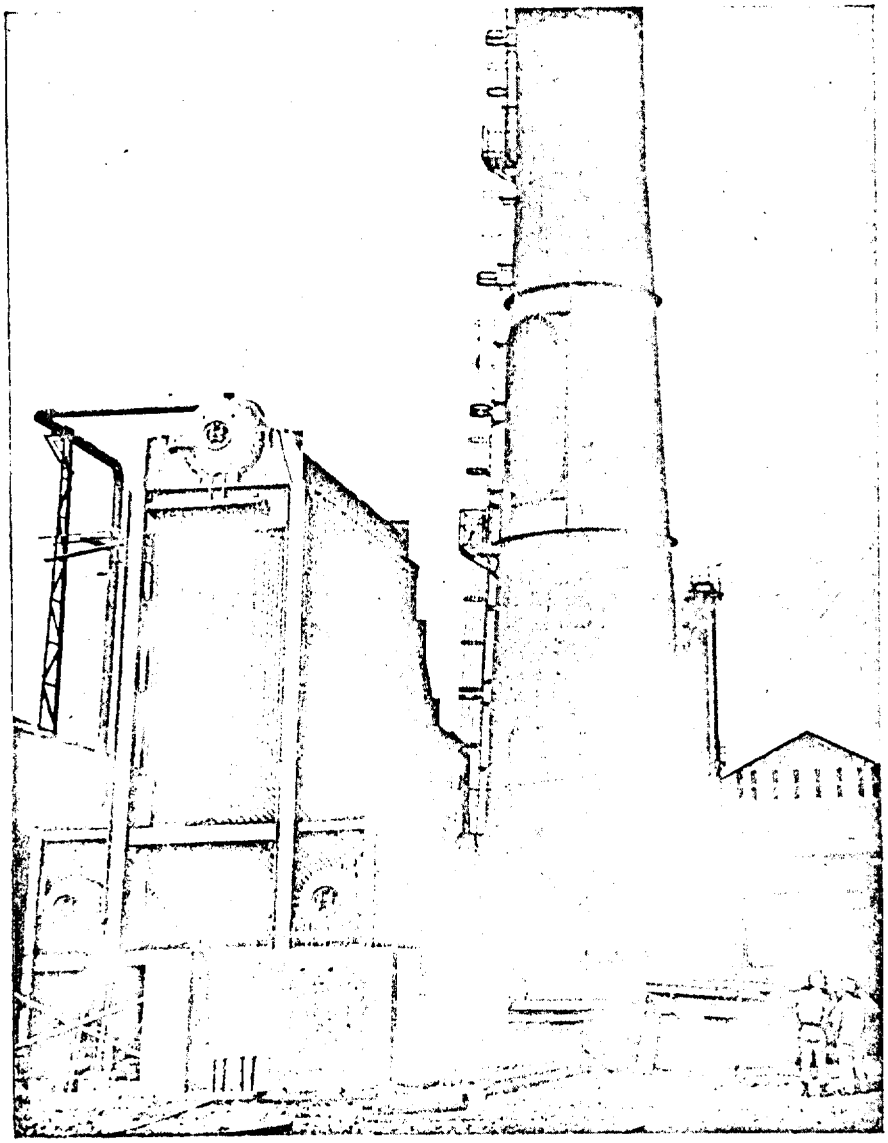

Figure 2.—Waste Heat Boiler under construction.

Figure 3.—Waste Heat Boiler.

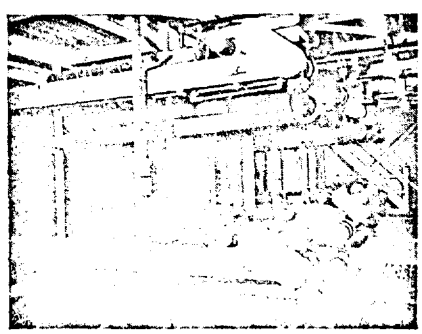

Figure 4.—Waste Heat Boiler — automatic soot blowers.

(2) *Melt-Down Period* — which reduces the scrap to a partial molten state.

(3) *Hot Metal Addition* — Molten pig iron from the blast furnace is poured into the furnace. If the furnace is equipped with oxygen lances, oxygen is turned on at this stage.

(4) *Lime-Up and Flush* — This indicates that the limestone reactions are completed.

(5) *Refining Period* — during which the carbon content is reduced and other impurities are controlled according to the heat specification.

(6) *Tap Out.*

In the initial stages of Stelco's Open Hearth Air Pollution Control Program, tests were conducted to determine the dust loadings in the waste gases and to obtain other pertinent data required for the design of dust collecting equipment. The first series of tests, covering every period of the heat cycle, was made before the Open Hearth furnaces had been equipped with oxygen lancing facilities.

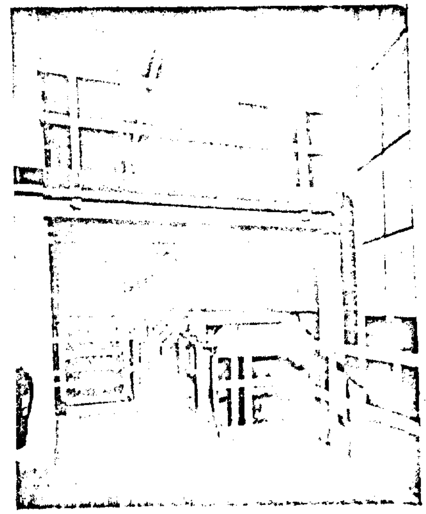

Figure 5.—Waste Heat Boiler — side wall shot.

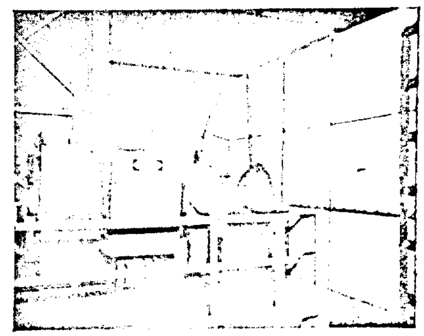

Figure 6.—Induced draft fan and motor.

Table I is a summary of the results obtained on No. 33 Furnace, a 325-ton-capacity furnace, during normal operating conditions, with no oxygen lancing.

At regular intervals, the flues and the checkers are blown with steam to remove any dust build-ups. This practice gives rise to abnormally high dust loadings in the waste gases. During the blowing period (18 hours per week), dust loadings of up to 14 grains per cubic foot have been measured. Although it was considered impractical to design dust collection equipment to cope efficiently with such loadings, the selected equipment would have to withstand such conditions without causing any operating difficulties.

Considering an average dust loading of 7.5 grains per cubic foot during flue and checker blowing, the emission rate, based on a weekly average, becomes 13.2 pounds per ingot ton. The moisture content of the waste gases increases to 23 per cent, by volume, during the blowing periods.

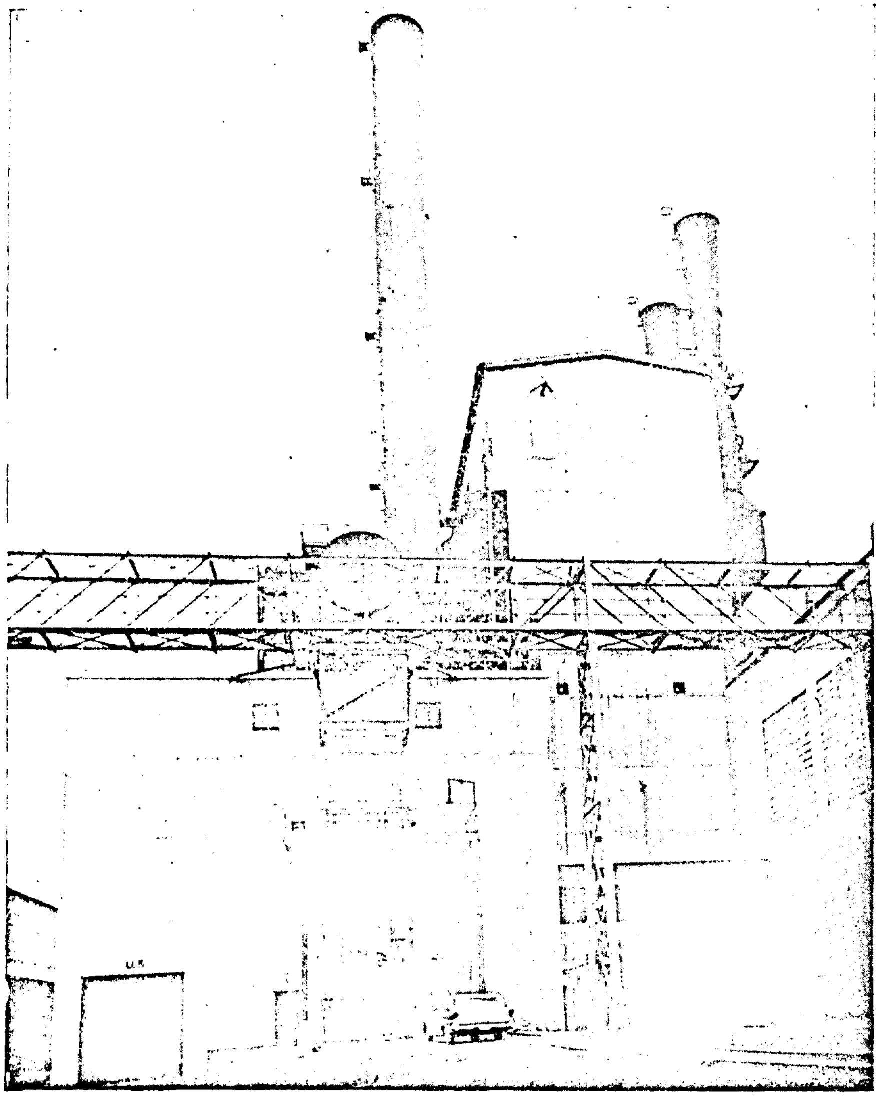

Figure 7.—Precipitator and Waste Heat Boiler.

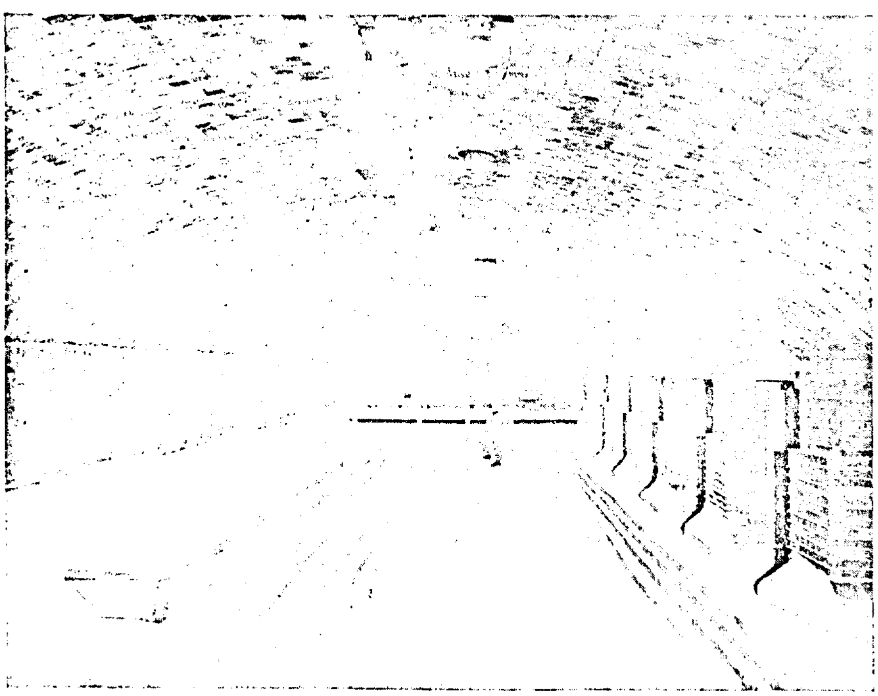

Figure 8.—Dimensions of Open Hearth furnace.

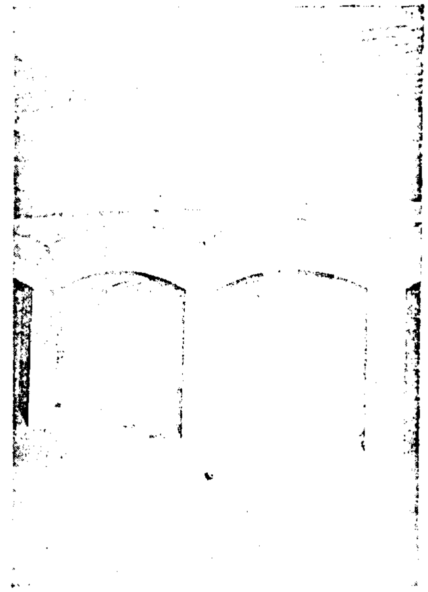

Figure 9.—Outlet — Second pass checkers.

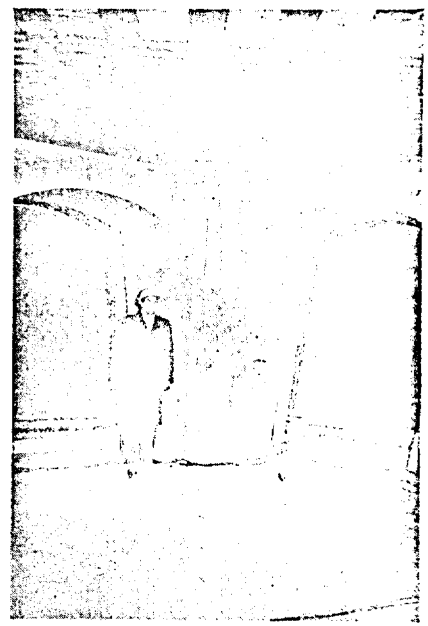

Figure 10.—Outlet — checker flues.

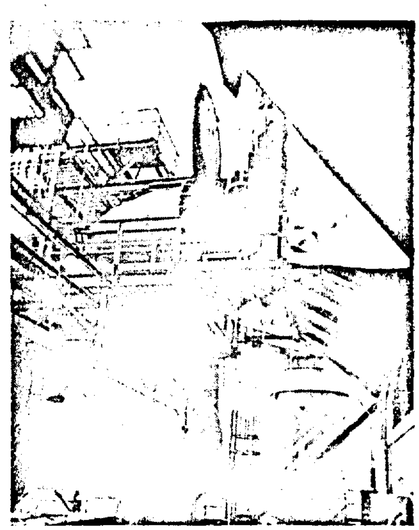

Figure 11.—Goggle valves — inlet to Precipitator.

TABLE I

Furnace Period	Charge to Hot Metal	Hot Metal to Lime-up	Lime-up to Tap	Tap to Charge
Average Fuel Firing Rate, (U.S.)-g.p.h.	1,300	1,180	1,090	670
Waste Gas Exhausted, s.c.f. per minute	83,500	75,200	70,700	47,600
Average Dust Loading, grs. per cu.ft.	0.56	0.61	0.18	0.11
Dust Emissions, lbs. per hour	400	390	108	44
Average Dust Loading for Entire Heat	0.43 grs. per cu. ft.			
Dust Emission per ingot ton	7.95 lbs.			
% Moisture in Waste Gases — % by volume	17.2	18.5	17.2	13.3
Temperature of Waste Gases After W.H.B.	650°F			

TABLE II

Oxygen Lancing Rates (c.f.m.)	Waste Gas Dust Loadings, grains per cubic foot
1500	3.2
2000	4.05
3000	5.08
4000	6.34
6600	to be determined

The introduction of oxygen lancing as a regular open hearth practice resulted in higher dust loadings. More sampling tests were taken during the blowing period (see Table II).

The lancing rate has increased from an initial rate of 1,500 c.f.m. to the present rate of 7,500 c.f.m. It is predicted that this rate could conceivably reach 10,000 c.f.m. and result in still higher dust loadings. Dust emission rates on No. 35 Furnace averaged 28 pounds per ingot ton at lancing rates of 7,500 c.f.m.

During the lancing period, the oxygen lances are lowered through the roof of the furnace to approximately 6 inches from the bath. At high lancing rates, the impact of oxygen on the bath causes considerable agitation. This action is believed to be partly responsible for the higher dust loadings. Also, extremely high temperatures are developed directly below the lances, causing the iron to vapourize. In the lower temperature regions, the iron vapours condense and are quickly oxidized. The resulting particles are very fine, being mostly in the submicron range.

The emission of such fine particles, even in small concentrations, renders the stack appearance objectionable. Collection efficiencies of over 99 per cent are required to adequately clean the waste gases during oxygen lancing. Emissions of red iron oxide dust exceeding .0.05 grains per cubic foot will give the appearance of a dirty stack. Studies made by the steel industry indicate that, to achieve this degree of efficiency on open hearth waste gases, the most widely used method developed to date involves the use of the electrostatic precipitator.

Nevertheless, the steel industry is constantly searching for new and more economical methods for use in the cleaning of open hearth waste gases. In the past, many methods have been tried. The latest developments in this field include the installation, for experimental purposes, of bag filters and a Venturi scrubber on two open hearth furnaces. It is still too early to evaluate the performance of this equipment. It is our opinion that the high moisture content (up to 25 per cent, by volume) of our waste gases would result in condensation problems if bag filters were used during winter operations. Although the efficiency of bag filters was considered adequate, we were concerned with the space requirements of such an installation, the high temperatures of the waste gases, the abrasiveness of the dust, the required maintenance of the equipment and the pressure drop across the system. Wet scrubbers also have high pressure drops (up to 50 ins. w.c.), resulting in high power costs. There do not appear to be any economical advantages in the initial capital cost of the scrubber, as compared to the precipitator. Serious corrosion problems, due to the sulphur in the waste gases, could be anticipated. Also, appropriate water-treating equipment would be required in order to clean the scrubber water effluent and thus minimize water pollution. The above-mentioned factors influenced our decision in selecting an electrostatic precipitator.

The electrostatic precipitator installed on No. 35 Furnace has a rated capacity of 315,000 c.f.m. at 550°F. It consists of two units, with five 6-foot sections per unit. Initially, only three sections per unit were energized. With a design efficiency of 95.8 per cent, this arrangement was intended to clean the waste gases emitted during normal operating conditions, where dust concentrations did not exceed 1 grain per cubic foot. The four vacant inlet sections (inlet values illustrated in Figure 11) were provided for the eventual higher dust loadings that could be expected during oxygen lancing. When required, the vacant sections could be energized to increase the collecting efficiency to 99 per cent.

In the short interval of time be-

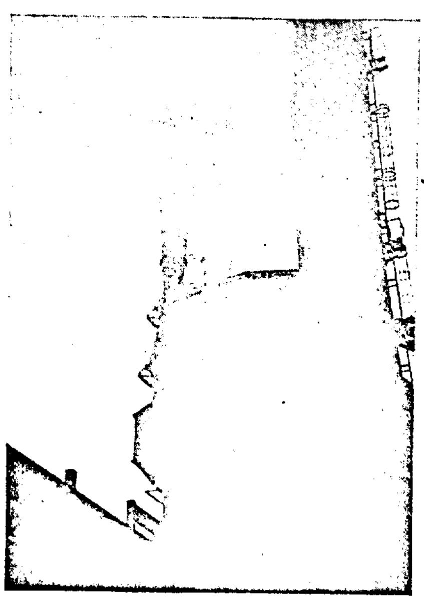

Figure 12.—Precipitator off.

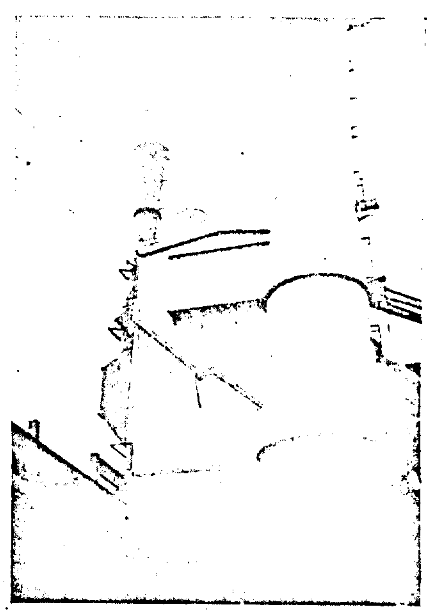

Figure 13.—Precipitator on.

tween the initial start-up of the precipitator and the introduction of oxygen lancing on the furnace, no serious operating difficulties were encountered. Motor-driven multi-vane dampers provide effective gas flow distribution. Venturi throats installed on the precipitator stub stacks serve to measure the flow through each unit, with the total gas flow being equally divided between each.

The pressure drop across the distribution dampers is measured by gauges located on either side of the dampers. A pressure drop of 0.25 in. w.c. is maintained to assure uniform gas flows through the precipitator electric field.

Under normal operating conditions, the precipitator performed efficiently (see Figures 12 and 13) and the stack remained clean throughout each period of the heat. Dust emissions could not be observed, even during the blowing of the flues and the checkers. During such periods, the bulk of the dust consisted of large particles (Table III). The agglomerated particles either settled out in the vacant inlet sections or were easily precipitated by the energized fields.

TABLE III

SIZE DISTRIBUTION

(per cent by weight)

Normal Operating Conditions .	
With Oxygen.....	90% below 7 microns 99% below 5 microns 95% below 1 micron
Abnormal Operations.....	50% below 60 microns 20% below 20 microns 6% below 10 microns

With the introduction of oxygen into the furnace, we immediately experienced numerous failures in the precipitator high-voltage control circuit and in the discharge electrode system. It was established, by use of an oscilloscope, that the failures in the control circuit were being caused by high-voltage transients entering the control circuit from the power line. These transients were originating from the precipitator, where heavy sparking was occurring when the open hearth furnace was being blown with oxygen. High dust loadings were responsible for this heavy sparking.

The electrical components affected by these transients were the silicon bridge rectifiers and the power amplifiers. The transients generated more heat than could be absorbed by these components, thus causing them to fail. The addition of capacitors and surge suppressors in the control circuit eliminated the transients and no further failures were experienced.

Another problem associated with the heavy sparking was the excessive breakage of the discharge electrodes. Each electrode failure required a four- to six-hour shutdown. It was necessary to allow the precipitator to cool sufficiently before entering it to remove the broken electrode. This problem would eventually be overcome when the vacant sections were energized and the electrodes positioned at a wider spacing. However, as there would be a delay of several months before this could be accomplished, it was imperative that temporary corrective measures be taken in the meantime. This was done by reducing the secondary voltage below the "spark-over" voltage. The reduction of energy input into the precipitator did not affect the efficiency to the same extent as the heavy sparking. Consequently, the precipitator operated more efficiently with the secondary voltage reduced, and electrode failure was eliminated. Nevertheless, under such conditions, the stub stacks still appeared dirty. It was evident that additional dust collecting capacity was required to cope with the new dust loadings.

The precipitator is presently (at time of writing, March, 1962) off the line, while the vacant sections are being filled with discharge and collecting electrodes. The performance data of the completed unit is submitted as a supplement to this paper.

The power to the fully energized precipitator is supplied by four silicon rectifier-transformer sets (Figure 14), each rated at 60 kv. and 500 ma., and by three 50-kv., 1000-ma. units. The four smaller electrical sets energize the four inlet sections. This arrangement of one electrical set per section reduces the total length of discharge electrodes connected to any one set. As the total length of interconnected discharge electrodes affects the stability of electrical discharges, this permits higher energy input and, consequently, higher efficiencies. The three larger electrical sets are so connected as to energize two precipitator sections, one from each unit. As the sparkover voltage in each section is affected, in part, by the decreasing dust concentration as the waste gas proceeds through the precipitator, every section in a unit may be operated at different voltages.

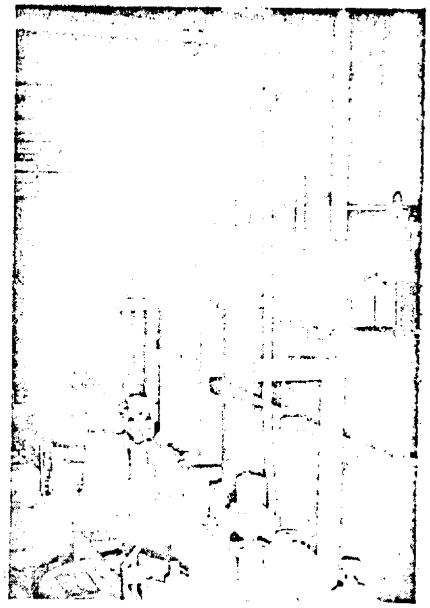

Figure 14.—Operating floor of the precipitator transformer-rectifier units.

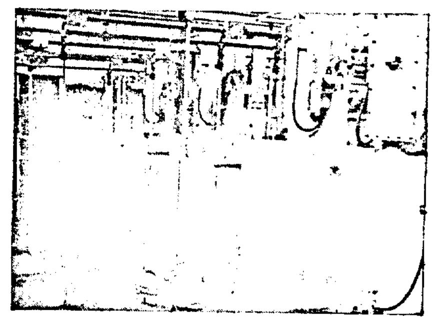

Figure 15.—Insulator compartments, rappers and manhole doors.

The discharge electrode system is of the wire and weight type, supported by porcelain insulators. Mounted on the operating floor of the precipitator and out of the waste-gas stream, the insulators may be maintained without entering the precipitator. The insulator compartments (Figure 15) are kept under pressure with heated forced draft air. Also, due to the presence of graphite in the area, the ventilation air must be filtered to protect the insulators. In the inlet sections, barbed wire discharge electrodes are used. Plain 0.105-in. plough-steel wire is used in the outlet sections. The total length of discharge electrodes is 64,000 feet.

Throughout the precipitator, the collecting electrodes, which are 6 ft. wide and 24 ft. high, are fabricated of 4 mesh, 0.054 wire screen. The screen design permits the electrode to be exposed to high temperatures (850°F) without causing warping or distortion. With the electrodes spaced at 11¾ inches, the inlet sections have a total of twenty-eight ducts each. Although the wider spacing reduces the collecting surface area, higher operating voltages are possible without causing sparkover. The remaining sections have thirty-seven ducts, with the electrodes spaced 9 inches apart. The total surface area actually available for collection is approximately 125,000 square feet.

The rapping system used for the removal of the dust deposited on the discharge and collecting electrodes consists of ninety pneumatic rappers. Fitted with energizing solenoids which are automatically controlled, each rapper is activated individually and in sequence. Individual rapping eliminates the possibility of dust puffs being emitted, a phenomenon which could occur if several rappers were operated simultaneously.

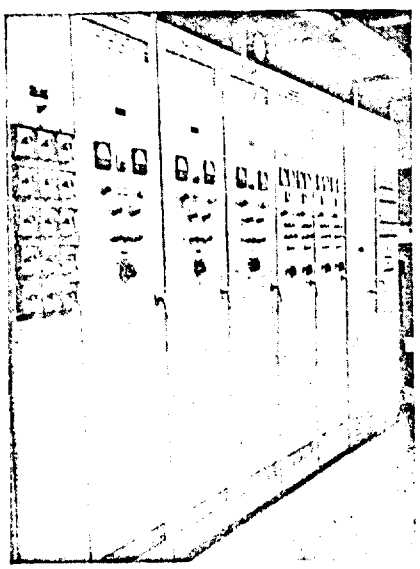

Figure 16.—Precipitator control panels.

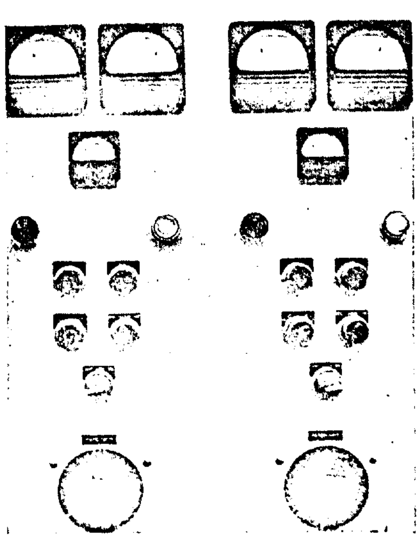

Figure 17.—Control panel for inlet sections.

A suitable alarm circuit, with indicating lights and horns, is incorporated into the system and located in the precipitator control room. (For illustration of control room and panels, see Figures 16 and 17). The alarm circuit will warn of a power failure to any section of the precipitator, of a breakdown in the dust conveying system, of interruptions in the compressed air supply to the rappers, of excessive sparking in the precipitator, and of high dust levels, due to bridging or build-ups, in the precipitator hoppers.

The precipitated dust is continuously removed from the electrically heated precipitator hoppers by screw conveyors. The dust is dropped into a surge bin which has sufficient storage capacity to hold the dust collected during a 24-hour period. Due to the fact that open hearth dust has an angle of repose of approximately 90°, it was very difficult to empty the surge bin. A pneumatic vibrator was installed on the bin and was found to be very effective in moving the dust into the screw conveyor which feeds into a pug mill (Figure 18). From the pug mill, the dust is trucked to a nearby site and stockpiled.

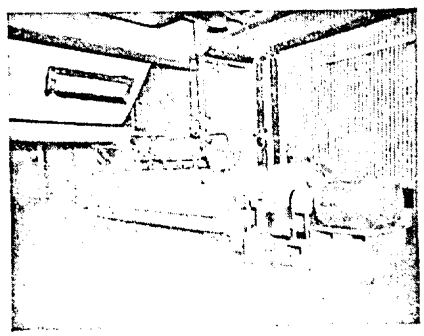

Figure 18.—Pug mill and motor.

Approximately 35 tons of metallurgical dust per day are now collected by the existing open hearth precipitator. This amounts to 28 pounds per ingot ton of steel produced. The steel industry is faced with the problem of finding practical and economical means of disposing of this waste material. In some instances, this dust is transported, in a dry state, over a long distance and dumped into some remote area. This is obviously not the solution to the problem. The extremely fine dust, extracted at a considerable cost from the waste gases, may be easily entrained into the atmosphere. To successfully abate this secondary source of air pollution, it then becomes necessary to chemically spray the dust piles, adding further to the cost of pollution control. Similarly, the fine dust cannot be dumped into the lakes and rivers, as this would create a water pollution problem.

TABLE IV

Chemical Analysis of Open Hearth Dust Sampled From No. 35 Furnace Precipitator

	Maximum	Minimum
Fe	63.5	56.0
P	0.122	0.060
Mn	0.55	0.43
SiO_2	1.56	1.16
Al_2O_3	0.44	0.15
CaO	1.06	0.68
MgO	0.44	0.32
Cu	0.16	0.11
Cr	0.11	0.06
Ni	0.05	0.03
ZnO	16.60	2.05
Pb	0.74	0.40
Cl	1.01	0.26
Na	0.70	0.30
S	1.90	1.03
C	0.125	0.065
SnO_2	0.03	0.01

This open hearth dust contains a percentage of iron oxide which is equivalent to a high-grade ore and which could be returned to the sinter plant process. (See Table IV). Unfortunately, however, it also contains, among other elements, quantities of lead and zinc oxides which are deemed objectionable to blast furnace operations. In attempting to find a solution to the removal of these trace elements, The Steel Company of Canada has assigned personnel from the Research and Development Group to investigate various possible treatment methods. As more precipitators are erected on open hearth furnaces, dust disposal will become a serious problem. It is hoped that the present research efforts will be successful and that the value of the recovered dust will cover, in part, the operating costs of the precipitator.

Technical advances, changes in operational procedures and increased productivity have given pollution problems a new dimension. On new installations, such as No. 35 Furnace, these factors are taken into account and engineered accordingly. However, on some installations, dating only several years back, it is not always sufficient to simply add a piece of pollution arresting equipment to the existing waste-gas system.

At No. 3 Open Hearth Shop, The Steel Company of Canada is currently conducting engineering studies for the purpose of providing the existing furnaces with precipitators.

These studies indicate that, in all probability, it may be necessary to redesign the entire waste-gas system. The system (although new in 1952) was not designed for the high dust loadings resulting from recent advances in steelmaking processes. The fuel rate has increased to the extent that the draft reserve capacity is non-existent. The draft system cannot cope with any increased pressure drops caused by dust restrictions or new precipitators. We are also finding that the high temperatures experienced during oxygen lancing and the abrasive action of the high dust loadings have produced alarming mechanical problems on the boiler tubes and fan blades. New waste heat boilers and induced draft fans, selected for their ability to cope with these dust loadings, may have to be installed in the system before precipitators are considered. Unfortunately, although the addition of precipitators may adequately affect air pollution control, it does not solve the fuel firing and operating problems posed by high dust loadings. These factors are brought to your attention to illustrate that air pollution control cannot be divorced from operational problems.

The Sinter Plant

We will now consider metallurgical dust collection in our Sinter Plant. Basically, the sinter process consists of mixing ore fines and other ferrous dusts with coke, limestone and dolomite. The porous mixture is uniformly distributed on a continuous strand and briefly exposed to an intensive flame. The coke is ignited and the evolved heat fuses the burden to a hard, lumpy sinter. After combustion is completed, the sinter is sucessively passed through a crusher and a cooling conveyor, and then screened. The suitably sized sinter is charged into the Blast Furnaces, and the sinter fines are returned to the sinter process.

The sinter process, as are other allied processes, is a very dusty operation. The numerous conveyor transfer points require an extensive hood and exhaust system. A variety of dust collecting equipment is used to effectively clean both the dust-laden flue gases from the sinter strand and the exhausted air. These include wind boxes, settling chambers, cyclones, multiclones and wet scrubbers.

Dust collection in the Sinter Plant is relatively inexpensive, as compared to open hearth requirements. The total volume of gases to be cleaned from the sinter operation is less than the volume emanating from a large open hearth furnace. In addition, the sinter dust is coarse and is readily collected by almost any standard collecting method. (See Tables V and VI).

The sinter dust emitted from the crusher, and from points other than the sinter strand, has a high resistivity (Table VII). For this reason, manufacturers of electrostatic precipitators do not guarantee the performance of their equipment for this application, as long as the gases are not initially conditioned.

The following comments apply to some of the equipment used in the Sinter Plant.

Settling Chambers

Although the collection efficiency of settling chambers is relatively low (40 to 50 per cent), they are essential in the reduction, for subsequent collecting, of high dust loadings to lower and more reasonable levels. By removing the heavier particles from the gas stream, erosion problems in secondary dust removal equipment are reduced.

TABLE V

Sinter Dust — Physical Analysis

Under	Size — %
1 micron	3
2 microns	11
5 microns	35
10 microns	55
20 microns	75
40 microns	92

TABLE VI

Sinter Dust — Chemical Analysis

SiO_2	8.5
CaO	21.5
MgO	6.5
CO_2	16.5
Fe_2O_3	45.5

TABLE VII

Sinter Dust — Resistivity — Ohms Centimeter

% H_2O	Temperature 150°F	200°F	250°F
1.4	2×10^{10}	3×10^{10}	1.6×10^{12}
3.0	1×10^{11}	6.5×10^{11}	1.6×10^{12}
9.0	9×10^{10}		1.6×10^{12}

Multiclones

It is our opinion that this equipment is not suitable for sinter plant operations. Small-diameter collecting tubes erode rapidly during the handling of sinter dust and, consequently, increase maintenance costs.

Cyclones

Efficiencies of up to 80 per cent are obtained from cyclones, and maintenance costs are extremely low.

Rotoclones

This equipment is satisfactory if dust loadings are kept within the designed range. A collecting efficiency of 94 per cent is obtained. The disadvantage of a system using water to clean dust-laden air lies in the possibility of a subsequent water pollution problem. Additional equipment is required to treat the effluent from wet scrubbers.

Recently, some difficulties were encountered in the operation of the rotoclone (Figure 19). A change in the composition of the sinter burden altered the chemical and physical characteristics of the dust. A higher concentration of lime in the collected dust caused heavy dust build-ups on the scrubber's impellers. For this reason, it was not possible to operate the scrubber for periods longer than four days without cleaning the impellers. This could be done only on down-days of the Sinter Plant. Consequently, the unit was in operation less than 40 per cent of the time. To prevent such dust build-ups from occurring, we experimented with a chemical solution mixed with the scrubber water. The test proved very successful. The unit is now in operation 100 per cent of the time, with little cleaning required on Sinter Plant down-days. In addition, other benefits have been achieved through the use of this chemical solution in both the settling basin and the sludge filtering operation.

Recently, another dust abatement experiment has been conducted in the Sinter Plant. It has not, however, proved too successful thus far. A chemical spray system was installed at various conveyor transfer points. It was hoped that this system would affect the source of the dust, and thus decrease the amount that is now being collected. Unfortunately, the Sinter Plant is presently operating above its rated capacity, yielding a high-temperature sinter. During a trial run, the sprayed chemical solution was

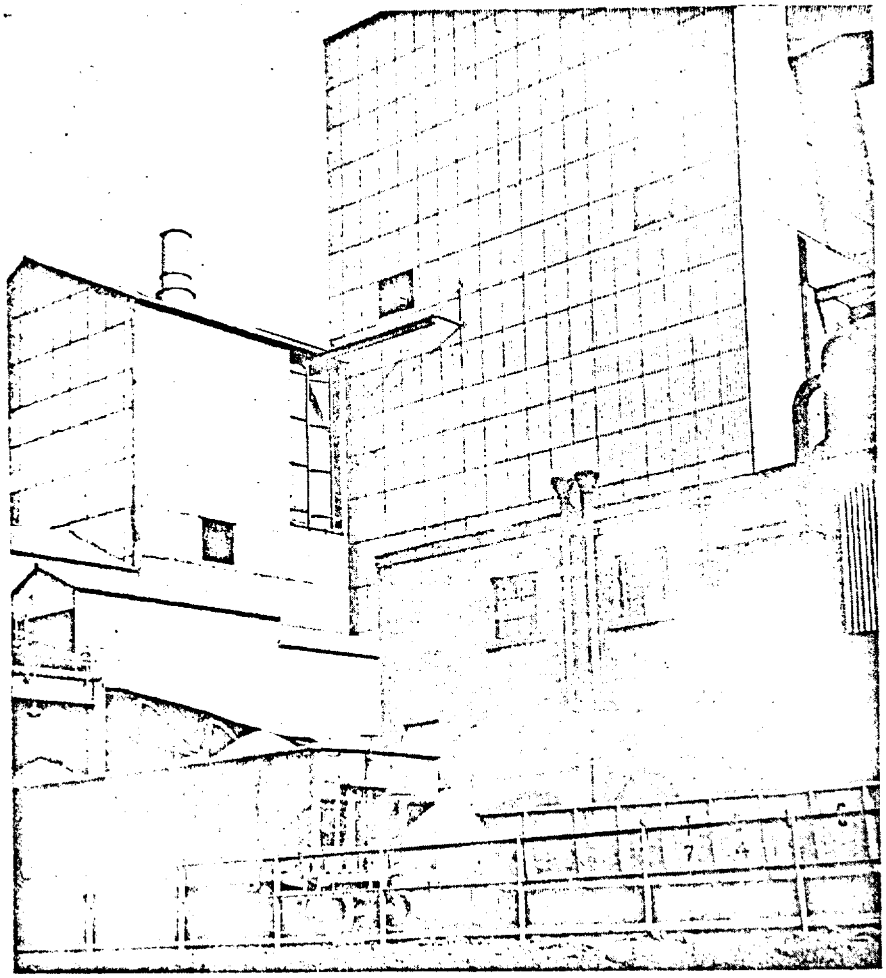

Figure 19.—Sinter Plant and rotoclone stack.

quickly evaporated by the hot sinter. In addition to problems in safety and visibility, the vapours given off plugged up air ducts and dry dust collectors.

A reduction in the production rate is contemplated which, it is hoped, will yield a sufficiently low-temperature sinter to enable the spray system to work efficiently.

Conclusions

In conclusion, we would like to point out that dust collection in the steel industry is not a paying proposition. Nevertheless, it must be done to combat air pollution. Much work remains in order to eradicate this problem in the steel industry. The magnitude of such a project makes it mandatory that progress in pollution control be achieved in a series of orderly and carefully planned stages. The true obstacle to any crash program is purely economic.

To illustrate, the cost of installing an electrostatic precipitator or an open hearth furnace approaches the million-dollar mark. It is, therefore, not difficult to understand that such unproductive capital expenditures are a serious drain on a company's financial resources and must, by necessity, be spread over a period of years.

Supplement

Precipitator Data

	Design	Operating	
		Non-Oxygen Lancing	Oxygen Lancing
Fuel Rate — (U.S.)g.p.h.	3,000	2,800	600
Volume — Waste Gases, c.f.m.	315,000	280,000	250,000
Temperature — °F	450	450	525
Oxygen Lancing Rate — c.f.m.	—	—	7,500
Inlet Dust Loading — grs. per c.f.			5.13
Outlet Dust Loading — grs. per c.f.			0.03
Efficiency — %	99.3		99.4

Dust Collected — 35 tons per day or 28 pounds per ingot ton

Operating Voltages and Currents — Primary and secondary

Sections	Non-Oxygen Lancing				Oxygen Lancing			
	V Prim. volts	I Prim. amps	V Sec. volts	I Sec. ma.	V Prim. volts	I Prim. amps	V Sec. volts	I Sec. ma.
1	270	29	32,400	110	400	29	48,000	120
2	300	60	36,000	240	385	58	46,300	210
3	300	100	33,000	470	330	105	36,200	480
4	350	110	35,000	560	360	110	36,000	580
5	380	130	34,400	820	380	135	34,200	860

Number of Precipitators — one

Number of Units per Precipitator — two

Sections per Unit — five — two inlets; three outlets.

Ducts per Section: — Inlet — twenty-eight; Outlet — thirty-seven.

Collecting Electrodes:

(a) size — 6′-0″ x 24′-0″

(b) spacing between electrodes

2 inlet sections — 12″

3 outlet sections — 9″

(c) total actual surface area — 125,000 square feet

Emitting Electrodes:

(a) Inlet Sections:

(i) type of wire — barb

(ii) lineal feet — 23,400

(iii) net effective lineal feet — 21,500

(b) Outlet Sections:

(i) size of wire — 105

(ii) type of material — plough steel — Stelco Bright M.B.

(iii) lineal feet — 46,500

(iv) net effective lineal feet — 42,624

(v) type — wire and weight

Power Supply: 550-v. — 3-Phase — 60 cycle

(1) Inlet Sections:

(a) number of energizer sets — 4

(b) type — silicon full wave rectifier; 500-v. primary, 50-kv. secondary, 500-ma. output; average power demand — 70 kw.

(c) precipitator control — 4-cabinet type for automatic voltage control

(2) Outlet Sections:

(a) number of energizer sets — 3

(b) type — silicon full wave rectifier; 500-v. primary, 50-kv. secondary, 1000-ma. output; average power demand — 100 kw.

(c) precipitator control — 3-cabinet type for automatic voltage control

Collecting and Emitting Electrode Rappers:

(a) type — pneumatic — 3″

(b) number — 90

(c) controls — automatic electric timer

Gas Velocity Through Unit — 3.9 ft. per second

Treatment Time — 7.7 seconds

The completed precipitator (five energized sections per unit) was started up in February, 1962. After selecting the optimum operating voltages for each section, the precipitator performed as designed. The only difficulties that we have encountered occur periodically during certain stages of the heat. Due to open hearth operating practices, the moisture content of the waste gases is reduced to a very low level. This, in turn, increases the apparent resistivity of the dust to the point where efficient precipitation is difficult. Considerable sparking occurs during this period.

This dry-gas condition is experienced shortly after the hot metal addition and normally lasts for 15 to 20 minutes. The reduction in moisture content is due to the following:

(1) Low firing fuel rate and low atomizing steam rate.

(2) Due to the low initial oxygen lancing rate, the temperature and the volume of the waste gases discharged from the furnace is low. Therefore, the automatic checker water cooling sprays are not activated.

The solution to this problem obviously involves increasing the moisture content of the waste gases. This is now done by any of the following ways:

(1) Coincide the blowing of the flues with this period.

(2) Coincide the soot blowing of the waste heat boiler.

(3) Inject steam directly into the waste gases.

An automatic steam injection system is now being installed to cope with this problem.

It may be of interest to note that the trend to increasing dust loadings with an increase in oxygen lancing rate, as shown in Table II, has been stopped. It was found that increasing the oxygen lancing rate without increasing the air supply to the furnace produced a reducing atmosphere. This resulted in excessive roof wear. During oxygen lancing, the air supply is now automatically proportioned to the oxygen rate of flow, the ratio being 7.5 cubic feet of air per cubic foot of oxygen. Therefore, during high lancing rates, the increased air supply has diluted the wash gases to some extent. This has resulted in more uniform dust loadings at various oxygen rates.

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INCO Scholarships

SCHOLARSHIPS with a value of approximately $5,000 each, based on a four-year university course, have been awarded to eight sons and daughters of Canadian employees of The International Nickel Company of Canada, Limited. The announcement was made recently by Ralph D. Parker, Senior Vice-President.

In addition to tuition fees, each scholarship annually provides $300 to the recipient and a grant of $500 as a cost-of-education supplement to the university. The awards are made on a one-year basis, and are renewable for three additional years or [illegible]il graduation, whichever is the [illegible]orter period. This is contingent on the winners satisfying the academic and conduct requirements of the universities where the scholarships are held.

The 1962 grants bring to a total of sixty-two the number of such scholarships awarded by Inco since the plan was inaugurated in 1956.

The new recipients of scholarships are as follows: John Gordon Farnham, a graduate of Oakville Trafalgar High School, Oakville, will enter Queen's University, Kingston, to study applied science for engineering. Mary Claudia Grassby, who has completed first year university at Marianapolis College, Montreal, will continue her studies in the Faculty of Arts and Science, majoring in languages. Terrence Curtis Green, a graduate of Port Colborne High School, has been accepted in the Faculty of Applied Science for Metallurgical Engineering at Queen's University. Margaret Ruth Harvey, a graduate of Thompson High School, has enrolled at the University of Manitoba in the Faculty of Arts and Science, majoring in mathematics. Riivo Ilves, a graduate of Lockerby Composite School, is enrolled at the University of Toronto in civil engineering. Peter LeRoy Myers, a graduate of Sudbury High School, will study applied science for engineering at Queen's University. Beverley Wharton, a graduate of Copper Cliff High School, will attend Queen's University, Faculty of Arts and Science, specializing in chemistry. George Robert Whiting, a graduate of Lively High School, will enter the Faculty of Arts and Science, University of Toronto, to study for an honours B.Sc. degree in mathematics and physics.