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Project for the treatment of an iron ore

James A. Pack

THESIS

TREATMENT OF AN IRON ORE

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Missouri School of Mines & Metallurgy.

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AN EXAMINATION THESIS

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So great is the degree of perfection that marks the various processes of iron production that it seems almost useless to essay to further study a subject which has received the best thoughts and lifetime labors of the greatest metallurgists of all ages.

Yet as we believe that there are still isolated cases whose various conditions have not received that consideration necessary to the most economical production of the pig; and believing that a most perfect knowledge of these conditions is essential to the final perfection of the metallurgy of iron; and knowing further that a wide extended interchange of experience & discoveries alone can perfect any science we have undertaken the study of an individual case, the conditions of which

will be developed in the course of this paper.
It is required here that there shall be produced in one day twenty tons of gray pig iron containing 3% carbon.

The furnace is situated in the midst of a rich iron producing region with fuel of easy access and also conveniently supplied with an abun-dance of water.
The exterior of the furnace is built of magnesian limestone while the interior is constructed of an extremely refractory sandstone, the intervening space between the walls being well filled with rubble.
The dimensions of this furnace are computed by means of a form-ula given by and are as follows;

Diameter	at	boshes	18.8 ft.
"	"	throat	9.4 ft.
"	"	crucible	4.7 ft.

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Diameter	of	boshes	18.8 ft.
"	"	throat	9. 4 ft.
"	"	crucible	4.7 ft.

Heights –
Belly from top of crucible – ––– 15.83 ft
Shaft – – – – –– 44.70 ft
Furnace – – – – – –– 75.20 ft
Angle of boshes – – – 65°.

The various sections of the furnace are shown on plates I & II.

Ores.

The ore used is a mixture of equal parts of three ores having the composition here annexed;

	I	II	III
Ferric oxide	91.612	73.604	79.437
Alumina	3.800	2.608	5.228
Lime	0.384	12.402	0.174
Magnesia	0.221	4.803	0.290
Phosphoric acid	0.156	0.230	0.074
Sulphur	0.151	0.214	0.073
Silica	3.853	6.491	11.941
Water	–	–	–
Manganese	0.000	0.000	0.081
	100.352	100.177	97.298

Hence the mean composition is as follows;

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Ferric Oxide - - - - -	81.551
Alumina - - - - -	3.878
Manganese - - - -	0.027
Lime - - - - -	4.320
Magnesia - - - - -	1.771
Phosphoric acid - - - -	0.153
Sulphur - - - - -	0.146
Silica - - - - -	7.428
Water - - - - -	0.724
	99.999

Containing 57.086% of iron.

It will be seen by calculation that there is needed for the production of twenty tons of pig containing 3% carbon 33.98 tons of ore; or for the production of each ton of pig there is required 1.70 tons ore.

Fuel.

The fuel used for the reduction of the ore is coke and has the composition.

Carbon - - -	78
Ash - - - -	13
Water etc - - - -	9
	100

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For every ton of pig produced there is consumed one ton fuel; hence, for each ton of ore there is required .58 tons of fuel of the given composition.

Flux.

It would seem on taking the oxygen ratios of the slag forming constituents of the ore that these matters were already present in the proper proportions for the removal of all impurities from the iron, but it is found by experience that with a refractory ore such a small percentage of flux is not sufficient to bring about the most perfect fusion.
Hence there is required an additional amount of flux which has the composition given under;

Calcic carbonate - - - - -	35.45
Magnesic " - - - - -	28.87
Alumina - - - - - - -	0.41
Silica - - - - - - -	36.06
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On inspecting the foregoing it will be observed that for each ton of pig produced there is required .247 tons of flux of the given composition.

Charge.

On considering the amount of ore reduced in twenty four hours and also the proportions of the ore, fuel & flux we see that the charge introduced into the furnace in twenty four hours is as given under;

Ore ---- 33.98 tons
Coke ---- 20.00 tons
Flux --- 4.94 tons
Total charge in 24 hrs 58.92 "

from which there is produced twenty tons gray pig containing 3% carbon.
The iron also contains other impurities, as sulphur, phosphorus & silicon, but these being

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The iron also contains other Impurities, as sulphur, phosphorus & silicon, but these being

small have not been considered.
The manner of charging varies
according to circumstances; but
in regard to time it is performed
with sufficient rapidity to keep
the furnace full to the throat.

The charge is elevated to the
throat of the furnace by a variety
of means, but in general in
level countries the apparatus
represented on Plate III Fig 2 is
resorted to, this being simply an
inclined plane on which runs
a car elevated by means of
steam.

Blast.

The blast is hot and is heated by
passing through a series of pipes,
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Plate III Figs 1 & 2.
The blast is heated by waste
gases from the tunnel head
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The amount of air thrown into
the furnace by the blower is
determined by means of a rule
given by Tunner and is found
in the given case to be 2800
lbs. per minute. At this point
in order that the minimum
amount of fuel shall be consumed
it is necessary that we know
~~that~~ the amount of moisture with
which the blast is charged that we
may thus compute the amount of
heat absorbed in the conversion of
this water into steam and also the
amount of heat returned in the
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It appears evident here that if all
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stated; but since in this case
the steam is generated by
means of direct fuel the
amount used is somewhat in ad-
vance of that given.
The pressure of the blast is
equal two inches mercury.

Slag.

The slag is a combination of sub-
silicate, unisilicate and bisilicate,
the bisilicate portion being augmented
by the ash of the fuel which is
nearly a true bisilicate.
Without considering the small per-
centages of sulphur, phosphoric acid
and manganese, portions of which
enter the pig iron, the slag has
the composition,

Silica ---	45.45
Magnesia ---	20.20
Lime ---	26.26
Alumina ---	8.08
Total	99.99

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The furnace used is the common open hearth blast furnace of the dimensions given. The blast is supplied by three-tuyeres. The various sections are shown on Plates I & II.

Figs. 1 & 2 Plate III show the apparatus for heating the blast, Fig 1 being the section through the pipes (p, p, p). The furnace for heating is at f. f., the flames circulating freely among all the pipes. Fig 2 shows the cross section of this apparatus.

The works should be constructed with a view towards the most economical handling of both the raw materials and the products. These objects were considered in the construction of the plan of works on Plate IV, the works being in the most condensed and convenient form possible.

Rolla Mo June 17th 1876. Jas. A. Pack

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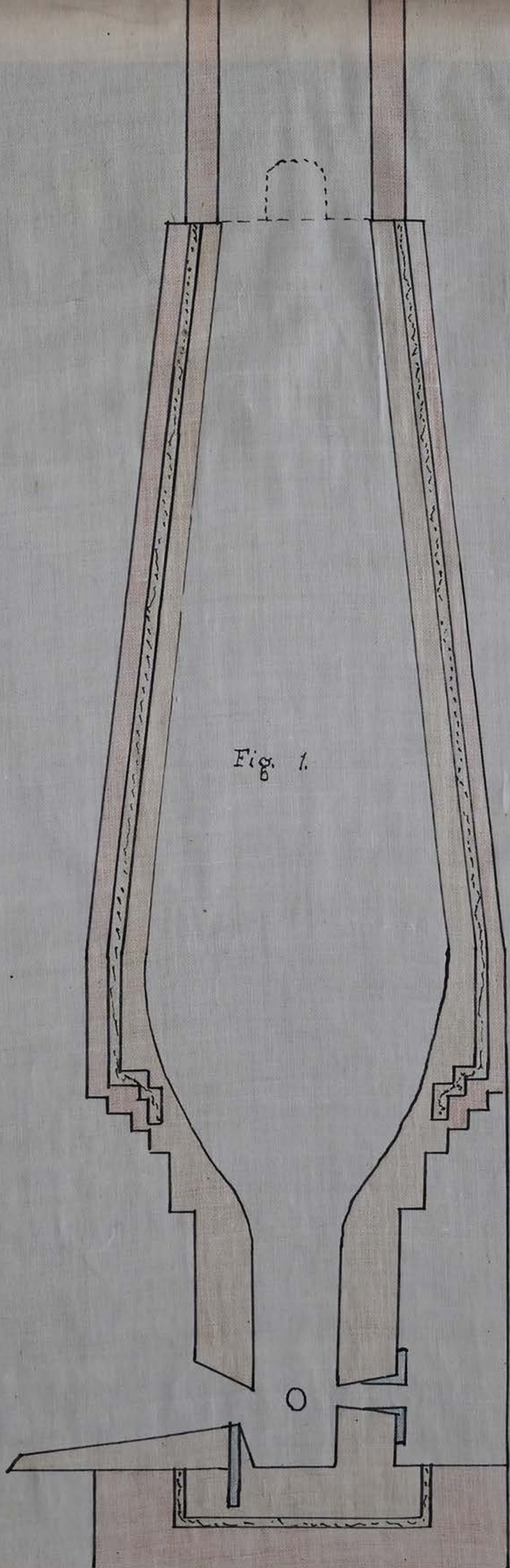
Rolla, Mo June 17th 1876. Jas. A. Pack

[Plates]

Plate I.

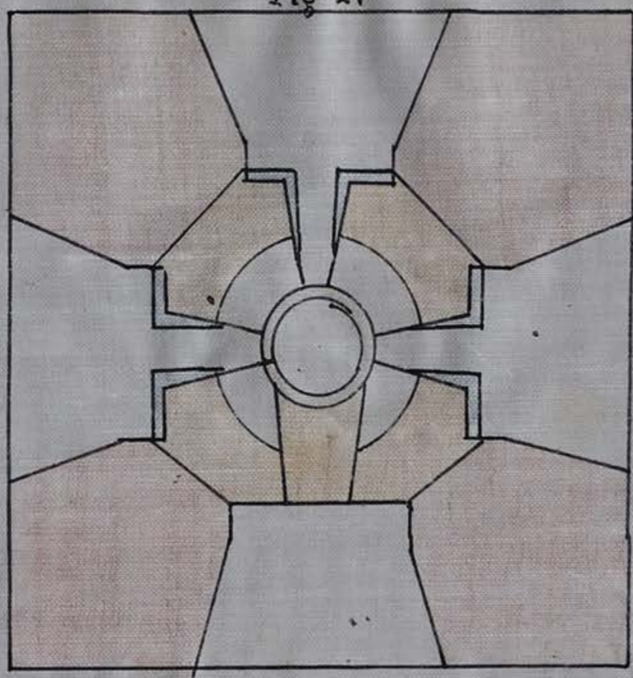


Elevation of furnace.

Scale 0 5 10 15 20 Feet.

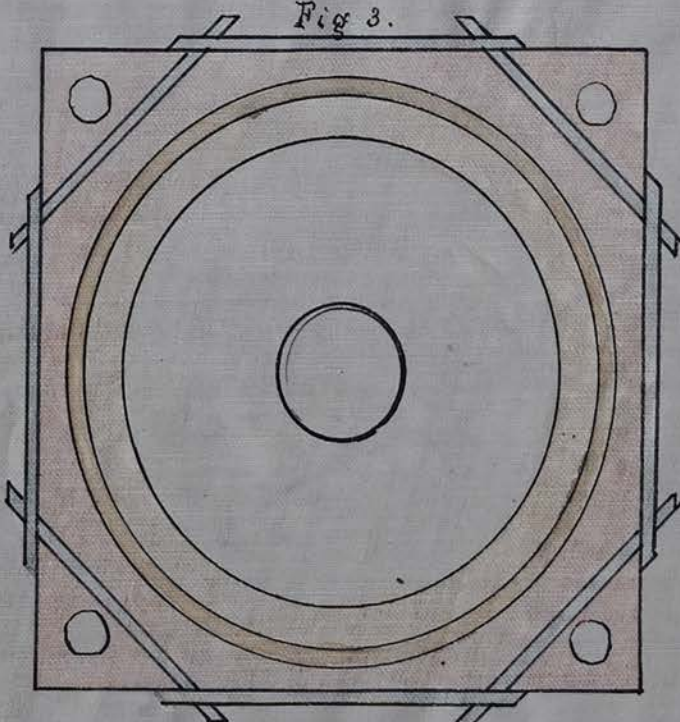
Plate II.

Fig 2.



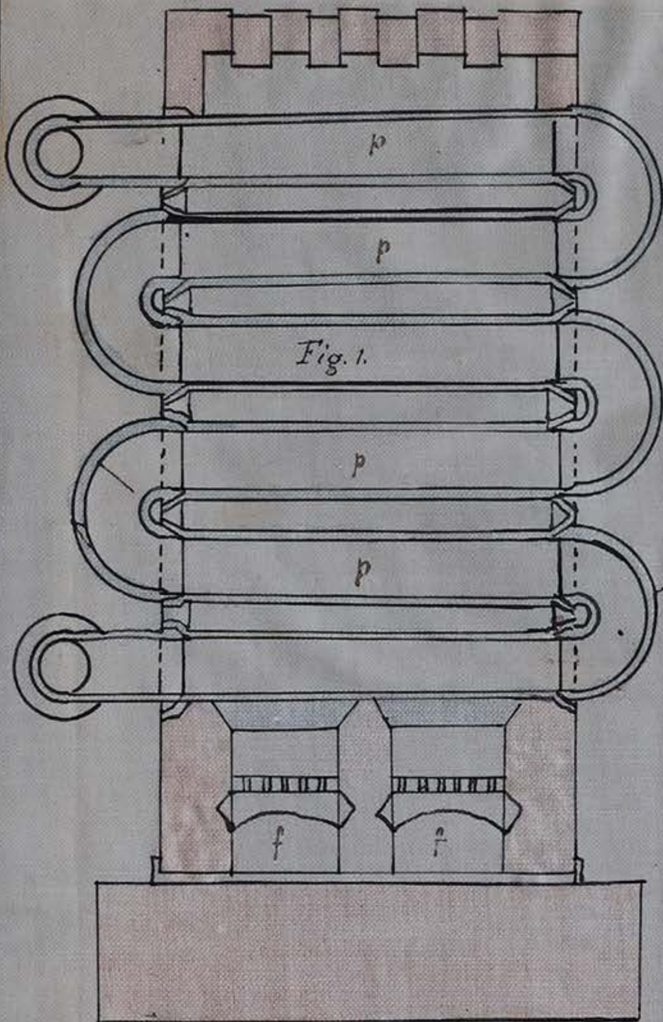
Ground Plan.

Fig 3.



Section through boshes.

Scale 0 5 10 15 20 Feet



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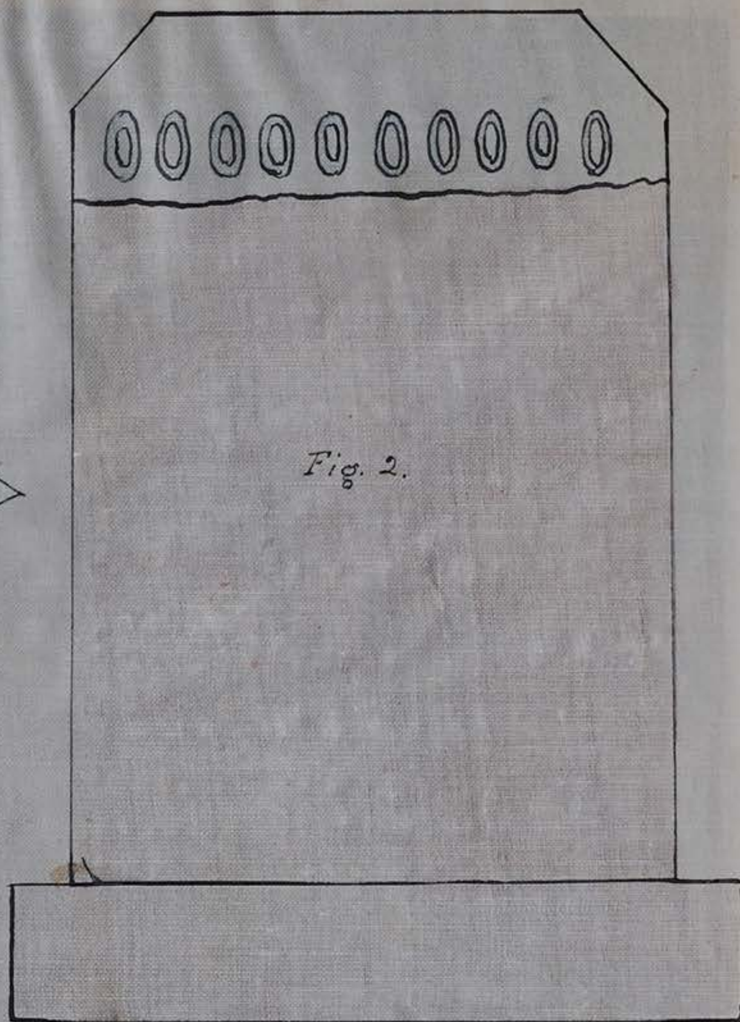
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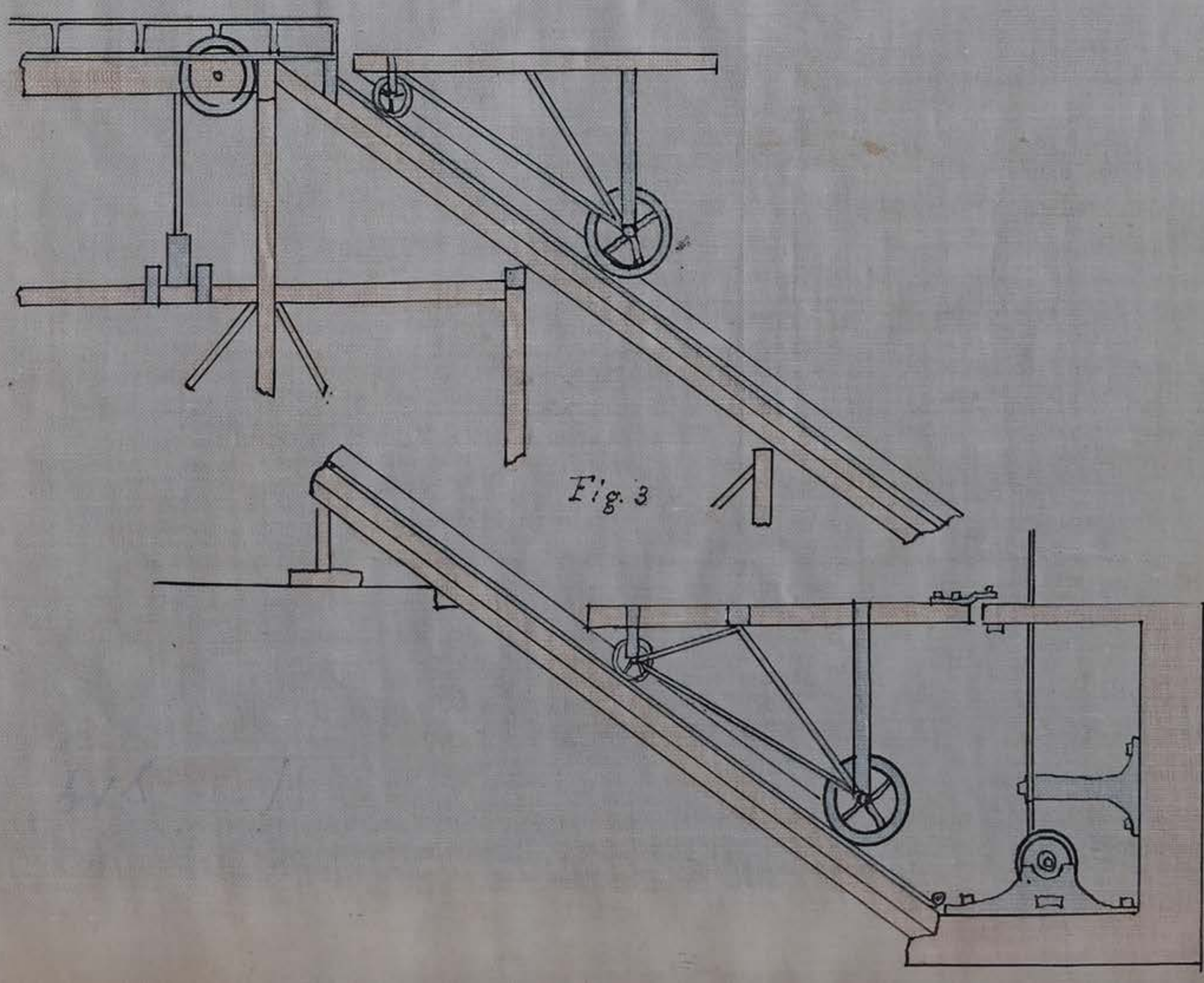
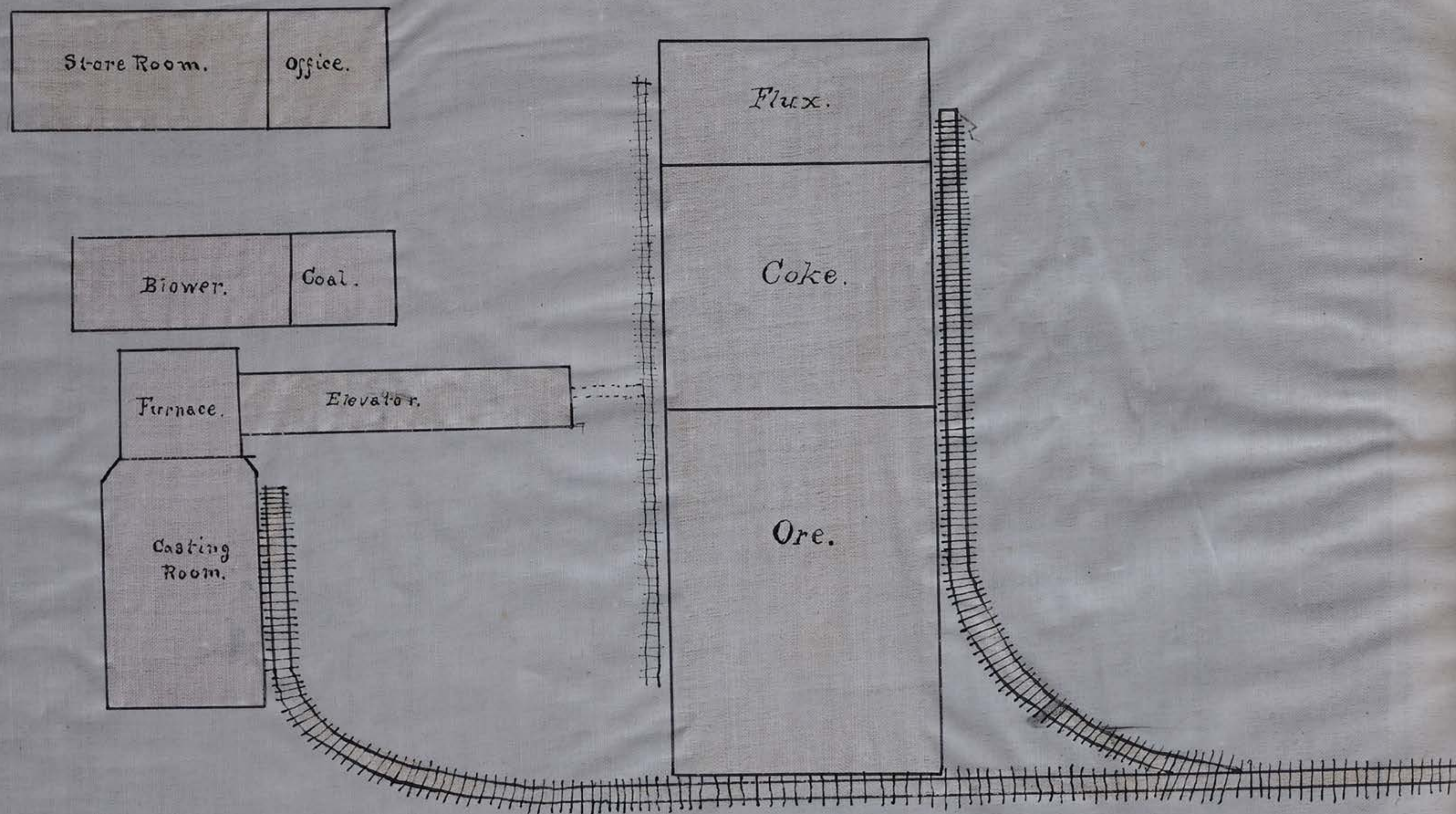


Fig. 3

Plate IV.



Plan of Works.