No. 804,689. PATENTED NOV. 14, 1905.

S. W. VAUGHEN & J. W. CABOT.

AUTOMATIC BLAST REGULATING APPARATUS.

APPLICATION FILED APR. 4, 1904.

2 SHEETS—SHEET 1.

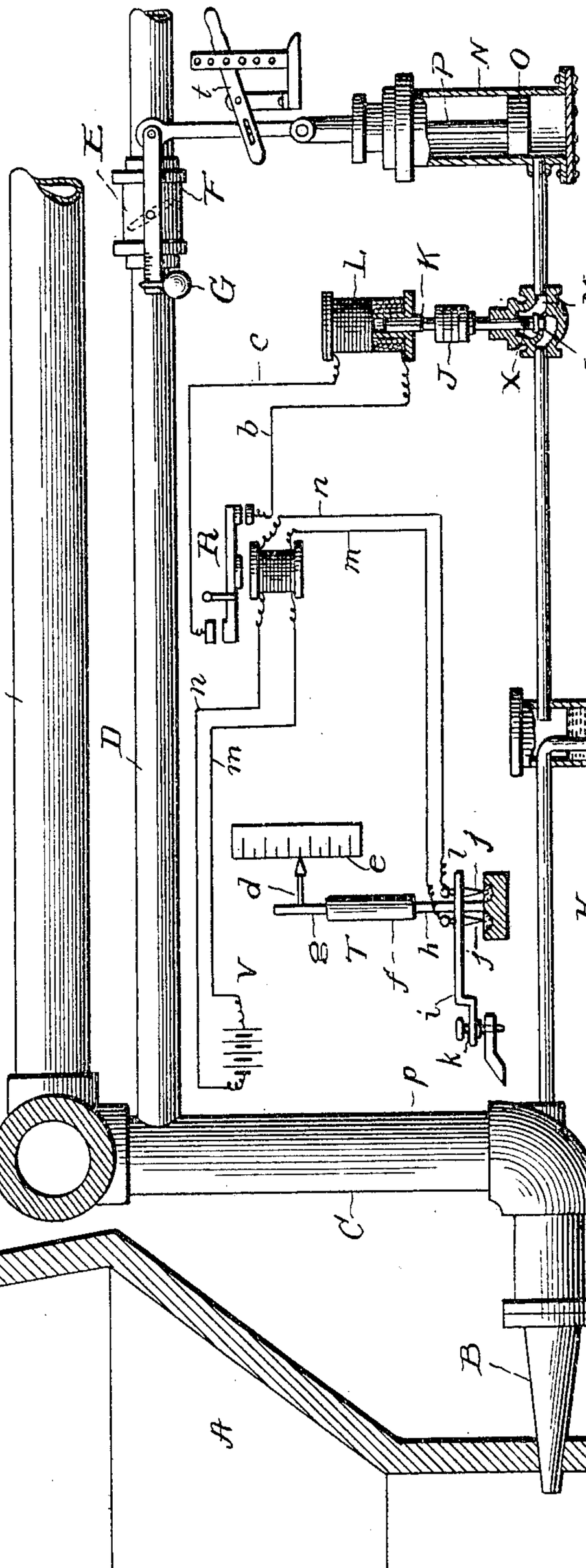

Fig. 1.

Witnesses

R. A. Boswell

Georg. M Anderson

Inventors

Samuel W. Vaughen,

John W. Cabot,

By E. W. Anderson their Attorney

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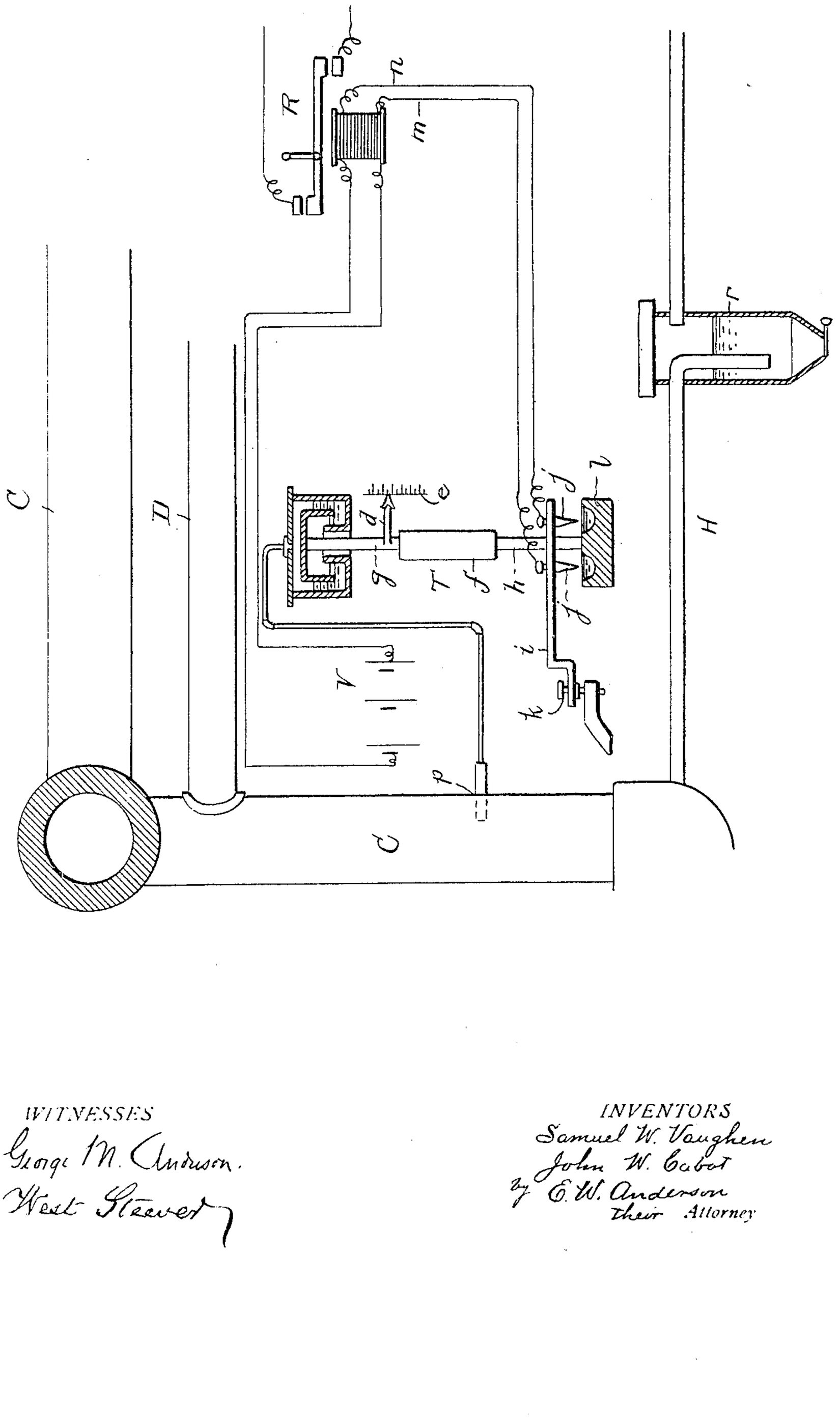

Fig. 2.

WITNESSES
George M. Anderson.
West Stevens

INVENTORS
Samuel W. Vaughen
John W. Cabot
by E. W. Anderson
their Attorney

UNITED STATES PATENT OFFICE.

SAMUEL W. VAUGHEN, OF LORAIN, OHIO, AND JOHN W. CABOT, OF BOSTON, MASSACHUSETTS.

AUTOMATIC BLAST-REGULATING APPARATUS.

No. 804,689. Specification of Letters Patent. Patented Nov. 14, 1905.

Application filed April 4, 1904. Serial No. 201,573.

To all whom it may concern:

Be it known that we, SAMUEL W. VAUGHEN, residing at Lorain, in the county of Lorain and State of Ohio, and JOHN W. CABOT, residing at Boston, in the county of Suffolk and State of Massachusetts, citizens of the United States, have made a certain new and useful Invention in Automatic Blast-Regulating Apparatus; and we declare the following to be a full, clear, and exact description of the same, such as will enable others skilled in the art to which it appertains to make and use the invention, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

This invention relates to the automatic regulation of the blast used in the smelting of metals from their ores; and it is particularly applicable in the manufacture of iron.

As is well known, pig-iron is manufactured in a blast-furnace, coke or charcoal being burned in such a furnace in admixture with iron ores and fluxes by means of a blast of hot air forced by blowing-engines through twyers. In order that the furnace may do the best work and run most regularly, it is desired to use at all times a certain regulated quantity of blast per minute. It has been found that the furnace works best when this uniform quantity of blast goes into the furnace through the twyers and up through the mass of coke, ores, and fluxes contained therein at a uniform temperature and pressure per square inch. Each furnace has a certain temperature and back pressure at which it works best, such being caused by the resistance of this mass of materials to the passage through it of the blast. Whenever the back pressure and temperature increase abnormally, it shows the furnace is not working right. It is desired to regulate this automatically. In practice the regulation is effected by hand, as follows: When the blowing-engines are kept going at a regular number of revolutions per minute, it is found that the resistance offered by the contents of the furnace to the passage of the blast varies according to certain conditions in the interior of the furnace. When the temperature increases abnormally, the back pressure at the twyers increases also, and, conversely, an increase of back pressure shows a condition of the interior of the furnace which produces an increase of temperature in the blast. Under these conditions it is customary to overcome the trouble by reducing the blast temperature by means of cold blast introduced into the hot-blast main through a branch pipe, thus providing a mixture of hot blast and cold blast of any desired degree of temperature. This mixture has the effect of loosening up the contents of the furnace and allowing the blast to penetrate more freely, and hence reduces the resistance or back pressure. To do this, it is usual to have a valve attached to the hot-blast main and to connect the hot-blast main directly to the cold-blast pipe coming from the blowing-engines. When this valve is opened, cold air is forced into the hot-blast main and there mixes with the hot blast, and the temperature of the hot blast is thus reduced as may be desired. This valve has heretofore been worked by hand. We have found that these variations in back pressure and variations in temperature sometimes occur simultaneously and at other times the one follows the other. It is important, therefore, in the best practice that either bad condition should be corrected as soon as it appears. Our improved device is designed to operate this regulating-valve automatically, the opening and closing of the valve being controlled by the conditions of the furnace itself in respect of either the blast-pressure or the blast temperature, or both.

A description of our invention follows.

In the accompanying drawings, Figure 1 is a sectional view, partly diagrammatic, showing the invention as applied; and Fig. 2 is a similar view, on a larger scale, showing the connection of the pyrometer T with the hot-blast main C

In the drawings, A represents a view in cross-section of a portion of a blast-furnace in which ores are reduced to the metallic state by the action of hot blast upon fuel and fluxes.

B is one of several twyers through which the blast enters the furnace, coming from a blast-heating apparatus and thence through the hot-blast main C.

D is a cold-blast pipe joining the hot-blast pipe and coming direct from the blowing-engines, by which cold blast may be mixed with the hot blast in the main C.

The extent of the cold-air admixture is

controlled by the valve E, operated by the lever F, having the adjustable counter-weight G. A small pipe H is connected to the hot-blast pipe C at some point between the valve E and the furnace, as at *p*, or it may be connected at any point of the cold-blast-supply pipe between the blowing-engines and the furnace. The other end of this pipe H is connected to an operating mechanism for operating the blast-regulating valve E. We do not confine ourselves to any particular form of operating mechanism, but may use any means of automatically operating the valve E. The form which we prefer, however, involves a self-closing valve I, having the weights J, the armature K, the solenoid L, and the passage or port M, leading to an operating-cylinder N, provided with piston O and piston-rod P, passing through a stuffing-box and connecting with the operating-lever F of the cold-blast-admission valve E. The solenoid L is connected, by means of the two wires *b c*, with any source of electric current, the circuit in the wires *b* and *c* being closed and opened by the circuit-breaker R.

T represents the moving portion of a pyrometer, having an index-finger *d* moving over a scale *e*. We prefer a pyrometer in which *f* is a weight suspended by the rod *g*. In operation the weight *f* is caused to rise and fall by another part of the pyrometer inserted into the hot-blast pipe C at some point, such as *p*. When the temperature of the air in the pipe C rises, the weight *f* rises, and falls when the air temperature falls. To this moving part of the pyrometer we suspend by the rod *h* the mercury-cup *l*. The rod *h* passes freely through the carrier *i*, to which are attached the needle-points *j j*, the distance of the points above the mercury being adjustable by the screw *k*. Each needle is connected to a pole of an electric battery V, and when the mercury-cup *l* is in such position that the needles *j j* touch the mercury the circuit in the wires *m n*, the circuit-breaker R, and the battery V is complete, and the circuit-breaker R then closes the circuit in the wires *b c*, thus causing the solenoid L to become active and to draw up the armature K, attached to the stem of the valve I.

The operation of the invention is as follows: Under normal conditions in the interior of the furnace A the cold-blast-admission valve E remains closed and all the air-blast in use is hot blast coming to the furnace from a blast-heating apparatus through the pipe C, and its temperature is the same in all parts of the pipes C and B. Its pressure is also uniform throughout the pipes C, B, D, and H, because these different branches are all connected together. This normal pressure acting through the pipe H under the pilot-valve I is not sufficient to lift the valve and the adjusting-weight J as long as the solenoid L is not acted upon by the electric current controlled by the pyrometer. The pilot-valve I remains closed, as well as the cold-blast valve E. If, however, the temperature or pressure at the twyer B should increase above the normal—that is to say, that at which the whole apparatus is set—the back pressure in the pipe H increases and tends to lift the pilot-valve I, and at the same time the blast temperature in the pipe C rises, producing an effect through the pyrometer upon the moving part T thereof, causing such moving part to rise, bringing the mercury in the cup *l* into contact with the needles *j* and establishing an electric current through the wires *b c* by means of the circuit-breaker R, thus causing the solenoid L to become active and to lift the armature K, attached to the valve I. The combined effect of the lifting of the solenoid and that of the pressure exerted by the blast in the pipe H upon the valve I is to open it, and connection is thus made between the blast-pressure at B and the operating-cylinder N through the passage-way M in the valve I, the blast having first passed through a gas-washer *r*, partly filled with water. The operating cylinder or motor then opens the cold-blast-mixing valve E and admits cold blast by establishing a direct connection between the blowing-engine and the hot-blast pipe, and thus producing a mixture of cold and hot blast in the pipe C. This has the effect of correcting automatically at once any abnormal condition of temperature or back pressure in the furnace. The valve I may, however, automatically operate under the influence of either of these conditions acting alone. Whichever of the abnormal conditions may manifest itself first immediately affects the pilot-valve, opening it and causing the operating-cylinder to open the regulating cold-blast valve. As soon as normal conditions in the furnace are restored the temperature and pressure in the twyer B and pipe C fall to the normal the pyrometer allows the moving portion T to fall, so that the needles *j* are not in contact with the mercury in the cup *l*, thus breaking the circuit in the wires *m n* and *b c*, the solenoid L becomes inactive, and the pressure under the valve I is reduced, so that the valve I then closes. This brings the port X in the hollow stem of the valve in connection with the passage-way M and allows the cylinder N to exhaust through the hollow stem, the piston O to descend and to close the valve E, thus shutting off again the supply of direct cold blast. The conditions of temperature and pressure in the twyer B at which it is desired to have the apparatus set in motion may be established at will and automatically maintained by setting the needle-point carrier *i* at the proper height above the mercury-cup *l* by means of the adjusting-screw K and by putting on or taking off

weights from the adjusting-pile at J to balance any desired pressure in the connecting-pipe H. We may also use the back-pressure pipe H without the intervention of the washing attachment *r*. It makes no difference whether the connecting-pipe H is joined to the blast system at the point *p* or at some other point so long as it is attached somewhere between the blowing-engines and the furnace itself.

If desired, the valve E may be set partially open by providing a stop at such a point that the lever *t* is free to make its full stroke in one direction, but will strike the stop before the full stroke is made in the other direction.

What we claim as our invention, and desire to secure by Letters Patent, is—

1. A hot-blast apparatus for furnaces having in combination a hot-blast stove connected to the furnace, a pipe for conducting hot air into the furnace, a valve controlling the flow of temperature-regulating air into the furnace, and means for opening such valve upon increase of back pressure or temperature in the furnace, substantially as specified.

2. In the smelting of ores with hot blast an apparatus for automatically mixing hot blast and cold blast together, consisting of a hot-blast pipe, a cold-blast pipe, a branch pipe connecting the two, a valve situated in said branch pipe, and means for opening such valve upon increase of back pressure or increase of temperature at the furnace, substantially as specified.

3. In the smelting of ores with hot blast, an apparatus for automatically mixing hot blast and cold blast together, having in combination a hot-blast stove connected to the furnace a pipe for conducting hot air into the furnace, a cold-blast pipe, a branch pipe connecting the two, a valve situated in said branch pipe, and means for closing such valve operative not only upon decrease of back pressure but also upon decrease of temperature in the furnace, substantially as specified.

4. A hot-blast apparatus for blast-furnaces having in combination a hot-blast stove connected to the furnace, a hot-blast pipe, a cold-blast pipe provided with an admission-valve, a motor for operating said valve, controlled not only by a pyrometer but also by back pressure, substantially as specified.

5. A hot-blast apparatus for furnaces having in combination, a hot-blast stove connected to the furnace by a pipe having a cold-blast connection provided with an admission-valve operated by a motor controlled electrically by a pyrometer and otherwise by back pressure, substantially as specified.

6. A hot-blast temperature-regulating apparatus for furnaces having in combination a hot-blast stove connected to the furnace, a cold-blast pipe for admitting air into the connection between the stove with the furnace, a valve controlling the flow of air through said pipe, means for shifting said valve controlled by a valve actuated by a combination of magnetic attraction and fluid-pressure, substantially as specified.

7. The combination with a blast-furnace, of a hot-blast main, a cold-blast-supply pipe, a branch pipe of said main connected to the cold-blast-supply pipe, a pivoted cold-blast valve, a lever connected to the pivot of such valve, a cylinder having a piston therein connected with said lever, a pipe for conveying the furnace blast-pressure to said cylinder, a balanced valve in said pipe, having a hollow stem, and an electrically-actuated armature, substantially as specified.

8. In the smelting of ores with hot blast, the combination consisting of a hot-blast stove, a hot-blast pipe connecting the stove and the furnace, a cold-blast pipe connected thereto having an admission-valve means for shifting such valve, and controlling mechanism automatically operated by electricity and air-pressure, substantially as specified.

9. In the smelting of ores with hot blast, the combination of a hot-blast stove, a hot-blast pipe connecting the stove and the furnace, a cold-blast pipe connected thereto, having an admission-valve, means for shifting said valve controlled by a mechanism operative by furnace-blast back pressure and by furnace-blast temperature controlling an electric current, substantially as specified.

10. In the smelting of ores with hot blast, the combination of a hot-blast stove, a hot-blast pipe connecting the stove and the furnace, a cold-blast pipe connected to the hot-blast pipe having an admission-valve, means for shifting said valve controlled by a combined electrically and pneumatically operated mechanism, operative by fluid-pressure and electrically controlled by a pyrometer, substantially as specified.

In testimony whereof we affix our signatures in presence of two witnesses.

SAMUEL W. VAUGHEN.
JOHN W. CABOT.

Witnesses for S. W. Vaughen:
J. A. DANIEL,
W. J. COULTER.

Witnesses for J. W. Cabot:
F. ERNEST CABOT,
WALTER L. BOWIE.