Economy of coal in house fires : or, how to convert an ordinary fire-grate into a slow combustion stove at a small cost / by T. Pridgin Teale.

ECONOMY OF COAL

IN

HOUSE FIRES

RIDGIN TEALE, M.A.

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ECONOMY OF COAL

IN

HOUSE FIRES;

OR,

HOW TO CONVERT AN ORDINARY FIRE-GRATE INTO A SLOW COMBUSTION STOVE AT A SMALL COST,

BY

T. PRIDGIN TEALE, M.A., F.R.C.S.

SURGEON TO THE GENERAL INFIRMARY AT LEEDS.

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CHARLES GOODALL, COOKRIDGE STREET, AND BOAR LANE, LEEDS.

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PREFACE.

This little book, an expansion of a lecture delivered on November 22nd, 1882, before the Leeds Philosophical and Literary Society, is published in the hope that it may contribute to the diminution of soot and smoke throughout the Kingdom, and so further one great aim of sanitary reformers, the improvement of the atmosphere of towns; that it may effect a large reduction in the amount of cinders and ashes, and so lessen municipal rates; that it may enhance the comfort of the sick room by rendering a fire more free from noise and dust and more lasting; and that it may induce many persons, including the delicate, the invalid, and the hardworked family doctor, to look upon a fire in the bedroom, not as a superfluous extravagance, but as a much needed comfort, nay, as a profitable investment towards the maintenance of health.

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ECONOMY OF COAL IN HOUSE FIRES.

"It is an ill wind that blows nobody any good." A smoky bed-room fire, by compelling the replacement of a dog-grate by a modified Parson's grate, forced upon my attention the principle of the economical and effective combustion of coal in house fires. Moreover, I cannot suppress the hope that the principles which are found to be true for house fires, will also prove to be true, in some degree, for the fires of steam boilers.

This discovery, for to me it was a discovery, seemed to be of such far reaching importance that I felt bound not only to communicate it to my friends, but also to publish it in the most effective way within my reach.

Let me guard myself at the outset on one point. The experience recorded in these pages has been gained almost exclusively from the use of *Good Yorkshire Coal*, and I am unable to say whether equally good results, or even approximate results, would be obtained from other kinds, and from inferior qualities, of coal.

The discovery which I made was this: that slow and efficient combustion of coal in house fires depends upon *two conditions in combination*; one, that no current of air should pass through the grate at the bottom of the fire; the other, that the space or chamber under the fire should be kept hot; and that these two points could be secured in ordinary ranges

at the cost of a few shillings. The means by which they are attained, consist in a *simple shield resting on the hearth, whereby the space beneath the fire is converted into a closed hot chamber.* Others have made the discovery before, and have embodied it in the invention of slow combustion stoves, but, as far as I know, no one has taught the public how this principle may, at a small cost, be applied to nearly every ordinary fireplace.*

A Popular Fallacy.

It is a popular fallacy, until recent years almost universally prevalent, that a fire will not burn unless a current of air passes through the bottom grate. This error is natural, seeing that the ordinary fire goes dead when the bottom bars are choked with chilled cinder and ash. Moreover, it is common enough to hear the question asked even by men extensively conversant with the use of coal and machinery, "but how *can* a fire burn without a supply of air"? *i.e.* air through bottom grating.

Waste of Fuel in House Fires.

It is a fact, constantly brought before the public by men of science, that the consumption of coal in house fires is miserably wasteful, and successful attempts have been made in recent years to lessen this waste, by retarding combustion, and by the invention of, so-called, "slow combustion grates."

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* Mr. Fletcher, of Warrington, has advised that the chamber under every fire-place should be made solid, with brick and fire-clay, in an interesting pamphlet on "Economy of Fuel for Domestic Purposes, with special reference to the improvement of old fire-places."—*Guardian* Office, Warrington.

The Remedy—"Slow Combustion."

Combustion can be retarded by cutting off the stream of air which passes underneath and through the centre of the fire.

This retardation has been attained mainly by three methods.

a.—By an iron plate which rests on the grating, and closes the slits against the passage of air. This method makes a fire burn slowly—saves coal—but spoils the fire. It fails because it does not secure the "second condition," the keeping of the space below the fire hot.

b.—A second method very extensively employed has been the substitution of solid fire-brick for the open chamber beneath the fire, as in the Abbotsford grates, in the various forms of Norwich and Parson's grates, made by Barnard and Bishop, and in the elegant and ingenious, and, I believe, satisfactory, Nautilus stove. The solid fire-brick far surpasses the simple iron plate. It fulfils the two conditions essential to effective slow combustion, by cutting off the "under-current," and by keeping the base of the fire hot. As the brick becomes heated, the fire burns brightly, but, when the fire is low, the brick cools, and the fire burns dull, and does not quickly revive when mended. Mr. Fletcher, of Warrington, one of the highest authorities on heating by gas, and coal, strongly advocates the fire-clay bottom, and in a lecture* explains how every grate can be made economical and almost smoke-consuming by filling up the chamber and the bottom of the fire over the grating with fire-clay. But he tells me that such ranges need careful selection of coal.

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* The lecture above referred to, which anyone interested in the subject would do well to purchase and read.

c.—In the third method, the space or chamber under the fire and the ordinary grating are retained, but the chamber is shut in in front by a shield or door, whereby the two essential conditions of "excluded draught" and "retained bottom heat" are secured. This principle forms the basis of all the best kinds of slow combustion stoves, whether it be applied as a sliding door, as may be seen in an old range in an old house in Mayfair, and in the stoves made by Smith and Wellstrood, of Dublin; or as a plate of iron, closing the space between the lowest bar and the hearth, as in the Coalbrookdale modification of the Parson's grate; or as a closed ashpan, which not only shuts in the chamber, but also catches the ashes: or as a simple shield standing on the hearth, and reaching as high as the bottom bar of the grate, which it is my object to advocate as applicable at a very small cost of money and trouble to every house, kitchen, and cottage in the kingdom which has not already been provided with a good slow combustion range.

I am convinced that the closed chamber under the fire is superior to solid brick. For ten or twelve years I have used and been satisfied with two Abbotsford ranges, and with their superiority to my ordinary grates. But since the "economisers" have been applied to my ordinary grates they have surpassed the Abbotsford ranges, giving a brighter fire, and one much more easily revived by "mending," even when nearly burnt out. The advantages of the open grating and chamber are that the ashes leave the cinders and the cinders burn brightly and tidily, and the chamber of air surrounded by brick on three sides with the floor provides a larger surface for storage of heat than the fire-brick bottom. This storage can, if necessary—*e.g.* in the case of inferior coal—be increased by substituting for the iron shield in front a shield of fire-brick, tiles, or other badly conducting material.

Our Fire-places should be a "Focus," not a Blast Furnace.

The fact is that we have been burning coal in house fires on an *entirely false principle*, on the principle of a blast furnace, letting cold air pass through the centre of the fire to blaze the coal rapidly away, and hurry the heat and half burnt gases unused up the chimney. We have gone back from the good old principle of the embers on the earth, when the hearth was a true "focus," a centre of accumulated, stored up heat. Let us then return to truer lines and make our fire-place again a "focus," a "crucible," even a "well" of stored heat, into which we put our fuel, first to be distilled into gas which, rising at a high temperature from its hot bed, meets the air gliding rather than rushing towards the chimney, and bursts into flame, communicating heat to the firebrick back and to the room. Then, when all gases have been burnt off, the red hot coke remains, and burns away in the bottom of the well at a slow rate, owing to the limited access of air, yet radiating abundant heat into the room. Surely in this we closely approach the ideal of Dr. Siemens, one of the great advocates of economy of fuel. We, in truth, burn our fuel twice over—first converting it into gas which will burn, and not escape unconsumed as smoke up the chimney to foul the air and blacken the neighbourhood, and then utilising the coke as it slowly melts away into ash.

The Construction of the Fire-place.

It is not my intention to express any opinion upon the various slow combustion stoves recently invented; firstly, because I am not competent to do so, having no personal experience of any except the Abbotsford; secondly, because a report is being drawn up by scientific experts after careful com-

parison and testing of the various inventions displayed at the Smoke Abatement Exhibition. It is probable that some such stoves are more economical in fuel, and more smoke-consuming than any of the simple forms of which I can speak.

There are, however, persons who wish to have some simple rules for making a satisfactory fire-place, or for altering an unsatisfactory one at a small cost, and who are at the same time unwilling to go to the expense of a new patent stove. To such I offer the following as embodying the results of observation and experience of ranges in my own house during the last few months.

Rule 1.—*As much fire-brick and as little iron as possible.*—Fire-brick retains, stores, and accumulates heat. Iron runs away with the heat, and chiefly in directions in which the heat is least wanted.

Rule 2.—*The back and sides of the fire-place should be fire-brick.*

Rule 3.—*The back of the fire-place should lean, or arch over the fire*, so as to become heated by the rising flame. The heated back raises the temperature of the gases and helps them to burn, thereby lessening the smoke, and sends abundant radiant heat, the most valuable product of a fire, into a room. *Vide* Plates II., III., IV., VII.

Rule 4.—*The bottom of the fire or grating should be deep from before backwards*, probably not less than 9 inches for a small room—nor more than 11 inches for a large room. Two points are gained by this unusual depth—one that space is allowed for the slanting or arching forwards of the fire-brick back—the other that there is plenty of room for the fire to "lie down," away from the direct draught up the chimney.

The fire is thereby made horizontal and slow burning instead of vertical and quick burning.

Rule 5.—*The slits in the grating should be narrow*—perhaps $\frac{1}{4}$-inch wide for a sitting-room grate, and $\frac{3}{8}$ for a kitchen grate. When the slits are larger than this small cinders fall through, and are wasted.

Rule 6.—*The bars in front should be narrow*—less than $\frac{1}{2}$-inch in thickness, so as not to obstruct much heat, and close together, $1\frac{1}{4}$-*inch apart*, so as to prevent coal and cinder from falling forwards, and *not more than four in number* for an ordinary fire.

Rule 7.—*The chamber beneath the fire should be closed in front by a shield or "economiser,"* the effect of which is to stop all current of air that would pass under the grate and through the fire, and so to keep the chamber, its floor, and its walls at a high temperature.

Construction of the "Economiser."

In describing the "Coal Economiser" I am anxious to give such directions as *shall enable any intelligent worker in iron to make one for any grate.*

The "Economiser" is a shield of sheet-iron which stands on the hearth, and rises as high as the lowest bar of the grate, against which it should fit accurately, so as to shut in the space or chamber under the fire. If the front of the range be curved or angular, as in most register stoves, the economiser will stand, owing to its shape—but if the front be straight, as in the Parson's grate, and in kitchen ranges, the economiser needs supports such as are shewn in the engraving. (Plate I.) Mr. Westmoreland, whitesmith, of Grace Street,

Leeds, who has made the economisers with great care, and very substantially, has given me the following technical details of construction :—

"Ordinary economisers" are made of 16-Gauge Charcoal Iron Plate, with $\frac{3}{8}$ bright steel moulding at the top, $\frac{1}{2}$-inch moulding at the bottom, and one or two knobs as required.

"Kitchen economisers" are made of 16-gauge iron, with $\frac{1}{2}$-inch semi-circle iron at the top edge; and with supports in scroll form of $\frac{1}{2}$-inch semi-circle iron.

Some makers use rather thinner iron plate and give strength by the mouldings. Some have used too thin plates, little better than tin, which have warped and so become more or less useless; and one ironmonger, who was fully instructed, even to the thickness of plate to supply, made one so flimsy that it curled with the heat, almost like brown paper, and became useless. Against such causes of failure I wish to give a caution.

Great care should be spent in taking the dimensions—as *every grate* has to be measured—as a foot for a boot. This renders it almost impossible to send orders to a maker by post. Some skilled person must take the measure, and take it accurately.

The dimensions to be taken are; firstly, the outline of the bottom bar of the grate. If it be curved, or angular, the outline can be well taken by a piece of leaden gas pipe, which, moulded to the outline, can then be traced upon paper or carried carefully away to the makers; secondly, the height must be measured from the hearth stone to the bottom bar.

I have described the "economiser" in its simplest and cheapest form, as applicable to nearly every ordinary range

whether in the cottages of the poor or in the houses of the wealthy, wishing thereby to make sure that the question of primary cost shall not check the spread of the economising movement.

Those, however, who wish for greater elegance can have more costly ones made of bright steel, or brass—or even have tiles inserted in the front. Specimens were shewn in the Library of the Leeds Philosophical Society on the day of my lecture by Nelson & Sons, Leeds; by Mr. Armistead, of Blakeborough & Co., Briggate, Leeds; by Mr. Hughes, Great George Street, Leeds; and the tiled economisers were shewn by Mr. Smith, of 63, Kirkstall Road, Leeds. Mr. Wilson, of Woodhouse Lane, and now no doubt others in the same trade have made them.

I have given these names of firms in Leeds who are making "economisers" of a right pattern in order that ironmongers, blacksmiths, and others in distant towns and villages, who cannot come over to see the economisers in Leeds, may be able to order one as a pattern or standard to work to, being anxious that there should be no failures through defective construction.

It is obvious moreover that the adaptation of the economiser need not displace the old-fashioned ash pan, and that the two can be combined, or that the economiser may be made like a drawer and catch the ashes. All such variations will work well provided that the main principles be adhered to of "cutting off the under current," and "keeping the chamber under the fire hot." But the simplest form is the best.

It is possible to "economise" a dog-grate by a shield which is like a drawer with front and sides only (*vide* plate IX.). Dog-grates as a rule give very little heat in proportion

to the coal used. This is mainly from want of firebrick. In one of my rooms the effective heat of a dog-grate has been much increased by banking up the sides and back with bricks —as heat accumulators. The fire burns more brightly, gives more heat, and does not burn more coal.

For cottagers who cannot afford even an iron plate, or who wish to satisfy themselves of the efficacy of the plan, Mr. Hewetson has suggested, and has found successful, the use of bricks piled in front of the space under the grate so as to close it. Seeing that the "ash chamber" under an "economised" kitchen fire need not be emptied oftener than once a-week, the labour of removing and re-arranging the bricks for this purpose is a small matter.

"The Front Damper."

This is the name I have given to a second shield, which hangs in front of the fire itself, converting the fireplace into a well. It was suggested by seeing an iron screen hanging in front of the kitchen range, but 2 or 3 inches from it, to shield the servants in hot weather from the direct heat of the fire. It occurred to me, that, if it were to hang close to the bars, it would more effectively protect against heat, and at the same time might act as a further economiser of coal. It also occurred to me to try a similar "front damper" for bed-room fires, in order to prolong their existence without mending. The intention is that the "front damper" should be put on at bedtime, and the effect is that there is usually some fire in in the morning. It is hardly necessary to say that the "front damper" must not be used without the "economiser," or it will make the fire burn more rapidly. The "front damper" is, however, *still on its trial*, and I am unable to speak either to exact results of its use, or with the same confidence in its favour as

in the case of the "economiser." The "front damper" is shewn in the kitchen fire in plate I., and in a bed-room fire in plate II.

The front damper should be made of 12-gauge charcoal iron, with hooks to hang on the top or second bar, the hooks arranged as in plates I., II.

The "Disc Poker."

"Economised" fires have rarely need of the poker. As a rule a mass of coal turned into red hot coke burns longer when not disturbed, and if an economised fire burns correctly there is no need of the poker for clearing the bottom of the fire to make it burn.

For a long time I have felt the want of a poker with a flat end for crushing in a fire which is burning too fiercely. At last I requested Nelson & Sons to fix an iron disc (*vide* plate VIII.) to the end of a short stiff poker, forming a magnified edition of the sugar crusher used by toddy drinkers.

The best time to use such a poker in an economised fire is when the fresh coal is heated through so as to be plastic, and capable of being beaten into a solid mass, and *before* it has reddened into coke. To beat the surface flat checks the rapidity of the fire, the surface at once being covered by flame, and after the gases are burnt off the coal becomes red coke.

A friend, who has two or three ranges to which "Economisers" cannot be applied, says that he can effectually economise his fire by checking the draught through it by the means of the disc poker.

In plate VIII. the disc is given of the actual size.

Should any ironmonger wish to make the "disc poker," let me advise him to obtain one of Nelson & Sons, Briggate, Leeds, as a pattern to work by.

How to Light an "Economised" Fire.

In lighting the fire, if there be no cinders on which to build the fire, it is well to draw away the economiser for a short time until the fire has got hold; but, if there be cinders left from the previous day on the top of which the paper and wood can be placed, then the fire may be lighted with the economiser in its place.

How an "Economised" Fire Burns.

The character of the combustion of an "economised fire" is well worth study, as it is very different from that of an ordinary fire.

When fresh coal is put on, even if the fire be low, there is such a reserve of heat that the gases very soon burst into flame. The coal burns like a piece of cannel coal, and gradually, as the volatile parts are distilled out, becomes a mass of red coke, retaining the original form of the piece of coal, and often swelling out like coke made for smelting iron. This coke, at a red heat, and with a restricted access of air, very slowly burns away to a fine ash. The cinders at the bottom of the fire, even in contact with the grating, remain hot, and continue to burn away to ash, and the bottom of the fire constantly clears itself by the frequent concussions of small cinders as they fall downwards through the fire, and shake the fine dust through the grating.

In fires burnt without the economiser, the ash chamber cools as the fire burns low, the iron grating is chilled and the cinders in contact with the grating *are cooled below their combustion point*, and, accumulating, form, with the ashes, a choking mass, black and impervious to air, and needing the poker to rake out the dead cinders, and let in air in order to revive the fire.

An "Economised" Fire Lasts Long.

One of the most valuable and striking points about an "economised" fire is the length of time it will burn without mending. My own bed-room fire (*vide* plates II., IV., VII.) frequently lasts 10 or 12 hours; being a good bright fire, with a rich red glow, for the greater part of the time. It frequently happens that my sitting-room fires are in in the morning although not mended late at night. A lady whose husband is an invalid writes—"The bed-room fire carefully made up, say at ten o'clock at night, will, undisturbed, keep good until eight in the morning, keeping the room during the entire night at one temperature."

The porter at the Leeds Infirmary, who has to be called up at all hours of the night, writes about his fire—"By the use of the 'economiser' I can save about 28 lbs. of coal per day. The fire burns much brighter, gives more heat, and only makes about half the quantity of ashes. About eleven o'clock at night, having allowed the fire to burn quite low, I replenish it. With the 'economiser' I have a fire all through the night till six in the morning; without the economiser I should be without fire by three in the morning."

Coke, Anthracite, and Peat.

In such a fire-place as is here recommended, coke, anthracite, and peat, will burn well, unaided by gas or coal.

My experience with coke (Leeds gas coke) is that it gives less heat, produces much more ash, and is, on the whole, more costly as a heat producer, than Yorkshire coal.

My experience with anthracite is that it will burn in an economised fire with firebrick surroundings, but that it is dearer, and gives out less heat than good ordinary coal, its advantage being that it produces no smoke. At the Langham Hotel anthracite is burned by the aid of an economiser, very much like mine, invented, I believe independently, by Mr. Crane.

Peat will burn well in an economised fire, but is needed in much larger quantity and weight than is the case with coal.

On Lighting a Fire at the Top.

This has been strongly advocated as economical and as a means of reducing smoke. Both claims are, I believe, true, and it is more scientific than the ordinary plan of lighting at the bottom. In practice there seem to be two objections, one that such a fire takes much more time to "lay"; the other that it requires about half an hour longer to burn into full blaze. As I understand it, the fire is laid as follows: First a thick layer of small coals, half the depth of the complete fire; then wood and paper; lastly, at the top whatever cinders can be collected from the previous day. The question, however, is worth study with a view to diminution of soot.

On Mending a Fire.

There is a great art in mending a fire. It is wasteful to throw lumps of coal higgledy piggledy on a fire. The red embers should be first broken up so as to make a level surface, then pieces of coal should be laid flat on the fire and fitted in almost like pavement; lastly, if the fire is intended to burn slowly and last very long, small coal should be laid on the top. An "economised" fire so made, will, in a short time, heat the coal through, and give off gases, which will ignite and burn brightly on the surface of the black mass, and when the gases are burnt off there is a large surface of red hot coke.

Does the "Economiser" ever Fail?

Sometimes the "economiser" does not save coal—occasionally it makes a fire more dull.

In my own scullery fire, chiefly used for the cooking of the household, the same amount of coal is burnt whether the economiser be used or not; and so far I have not succeeded in finding out the reason.

When the economiser fails to make a fire burn more satisfactorily, and more brightly, especially in the lower parts of the fire, there is some fault in the range. There is in such ranges too much *bare iron*, too little fire-brick surrounding the fire and the chamber beneath it, so that my second condition of keeping the "ash-chamber" hot is imperfectly attained. It is doubtful, also, whether some old-fashioned hob-ranges, with small gratings, and shallow from back to front, will give the usually satisfactory results with the "economiser." Another factor, which may diminish the effect of the "economiser," is the "dust flue," an opening under the grating which communicates with the chimney. Another source of failure is an overlooked ventilator opening in the hearth to help a fire to burn.

The Exception "Proves" the Rule.

Exceptio probat regulam—the exception *tests, puts to the proof—probes* the rule.*

Economisers were adopted for the fires in my wards in the Leeds Infirmary, with the effect of saving coal—but without attaining, in all instances, the usual improvement of a fire bright to the bottom. One cold day when the fires in one of my wards, had been allowed to go very low, a friend met me and said—"Why, you are starving your patients by your economisers." This put me upon the alert. Finding that in this ward the fires often burnt dull, and when low, did not quickly revive, I was convinced that something invalidated my condition of keeping the chamber beneath the fire hot. A close investigation discovered that the hearth instead of being stone or fire-brick was formed by a large iron chamber through which air passed from the outside to the interior of the ward, receiving heat in passing through the chamber. The iron hearth and chamber were replaced by fire-brick, and the back of the fire was inclined forwards (the Milner back), see plates II., III., IV., VII., and all was changed. The fire is now brilliant, gives out an enormous amount of heat, and renders the ward the warmest in the house, except two which have hot water pipes in addition to the ordinary fires. This result is gained with a reduced amount of coal.

Are the ideas Embodied in the "Economiser" Novel?

Certainly not. They were suggested to me by the Coalbrookdale range, shewn in plates II., VII. But more important than this is the fact, that others have arrived

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* Cf. Sir J. Paget, Bradshawe Lecture, *Lancet*, Dec. 16th, 1882, p. 1020.

independently at the same device, and have used it successfully. Not to speak of its embodiment in the solid brick of the Abbotsford grates, or in the slow-combustion inventions already spoken of, the following testimony by private persons has been given me.

Sir Thos. Acland writes to me: ". . . it is just the "plan on which, by the light of nature, I hit at my former house. . . I built my hearth about 4 inches above the floor, but with the middle made of an iron grating. I had an iron bar to keep the pieces of wood from tumbling forward. I used to put half a scuttle of coal on and light the fire with a few sticks on the top, "my theory being that the smoke is unconsumed fuel—that fire or flame at the bottom is cooled by black coal above, but that smoke below is burned into flame by heat above. I hardly know why I blocked up the front" (with a moveable trap stone, instead of fire brick) "except under the notion that a draught was not wanted through the early day, but I made the brick or block removable, so that I might turn the fire into an ordinary fire with a draught if I fed it at the top. In fact, I usually fed it at the side, pushing the new coal when warmed further in. I certainly saved a great deal of coal."

"Mr. Tomes, the well-known President of the Odontological Society, writes to a friend as follows: "I have but little doubt that an 'economiser' will do all that is claimed for it, but a necessary condition will be the use of coals that will not cake —inland coals that is. For some years past I have had in use an 'economiser' which differs from Mr. Teale's only in extending from the hearth to the top bar of the grate, instead of stopping at the bottom bar as in Mr. Teale's contrivance. The fire is thus placed in a well, receiving its air solely from the top whereby we are enabled to keep in the fire for months at a stretch. The plate shield or economiser is secured in its place

by two hooks which pass over the bars, but it can readily be removed and attached by two holes in its upper margin to two iron pegs fixed in the upper framework of the grate whereby the plate becomes a blower, and secures a bright fire for dressing by in a few minutes. I devised this method some years since, and have had the plates in use in each of our bedrooms ever since."

Further, in a letter to myself, Mr. TOMES says: "It may be desirable to state in your description that in order to make up a fire which shall last for 12 or 14 hours without further attention there should at the outset be a good body of fire, the red coals of which should be well pressed into the grate so as to fill the hollows. Then fill up with coals not too large, put on cinders and ashes, if any are present, and replace the plate. The coals I use are intermediate between the Newcastle and the Midland, that is they cake a little but not too much. If hollows are left in the body of the fire at making up you may in the morning find a black arch of coals on the top and an empty grate below, that is with such coals as we use."

I have given this interesting note in full, because it confirms from an independent source, and from a well-known scientific observer, the principles advocated in this book, and, moreover, gives an experience, with an Economiser of the most trying kind, of other than Yorkshire coal. With Yorkshire coal it would not be necessary to begin with a "good body of fire," but it would be well to let the fire go down, and there would be no fear of its burning hollow and leaving a black arch in any fire-place with fire-brick at the back and sides.

Can the Principle of the Economiser be applied to Steam Boilers?

On this point I must speak with diffidence, and give the only evidence that has as yet come before me. Mr. David Greig, junr., of the Steam Plough Works, Leeds, had partially cut off the air passing under the fire of a boiler (of locomotive type) in order to do away with the vibration caused by the full draught. To his surprise this was effected without diminution of steam. He then, in order to test my views, entirely shut off the air beneath the boiler, and stlll the steam kept up as before. The same quantity of fuel was delivered into the fire, but more refuse (unconsumed cinder) came away. Finally, the feeding, by revolving bars, was reduced 1th *i.e.*, from 12 feet an hour to 10 feet an hour, and steam was still maintained. The refuse was reduced by 2·31 per cent, the clinkers coming out free from cinder, and there was a saving in coal of 17 per cent.

Surely for the production of low pressure steam it must be wrong to have a strong draught. The function of a chimney should be to carry off products of combustion, not to produce draught. Where draught is needed there must be faulty construction of the fire chambers, in other words *insufficient storage of heat*—the heat below the fire, instead of being accumulated in fire-brick, being abstracted by the cold draught constantly blowing through the chamber, or by the portion of boiler which lies below the fire.

Three Main Points achieved by the "Economiser."

1.—Saving of coal.
2.—Diminution of smoke.
3.—Abolition of cinders.

I.—SAVING OF COAL.

This is a point which can be clearly established, at least in respect of Yorkshire coal.

Let me tell my own experience. Since the first of January last, I have used at my house at Headingley, less coal by more than $\frac{1}{4}$th. Three tons this year have done more work than four tons effected last year, or the two preceding years. During cold wintry weather the saving is fully $\frac{1}{4}$th; in warmer weather the saving is greater.

As a particular test, the coals used in the kitchen fire have been weighed during a series of days. In April and May six days without the economiser gave an average of 108 lbs. per day. Thirteen days with the economiser gave an average of 92 lbs. per day—a saving of 16lbs. per day. Since that time a new grating with narrow slits has been put to the bottom of the fire, and the "front damper" has been brought into use in warm weather. Under these new conditions an average of seven days gave 72lbs. per day, or a saving of 36lbs., equal to 3d. a day, and £4 a year. This fire heats the hot water system of the house, and the fire place is an old-fashioned open range.

Not content with my own experience alone, I sent a paper of questions to about 35 persons whom I knew to have used the economiser, and 30 answers were returned.

Question I.—Have you burnt less coal?

Twenty-nine out of the thirty reply in the affirmative.

Question 2.—How Much Less Compared with Last Year?

One saves $\frac{1}{5}$th.; five, $\frac{1}{3}$rd.; one, $\frac{2}{5}$ths.; three, $\frac{1}{2}$; one, $\frac{2}{3}$rds. One says: "A ton saved in the kitchen fire in three months,"

—*i.e.*, 24lbs. a day. Another says: "Three coal pans a week saved in the kitchen," 26s. a year. Another has saved 6s. in the pound since January last. Another saves 30 per cent. Seven cannot say. Six do not answer the question. One says: "Saving doubtful." A cottager says: "Her coal lasts six weeks longer." Of the thirteen who give no reply or cannot say, five have under another question testified to "great saving" of coal.

The question, however, arises, is not this saving attained at the cost of the loss of heat and of effective warmth? Information, therefore, was sought in order to test this point also.

Question 3.—Does the Economiser Spoil or Improve your Fire?

Twenty out of thirty testify to improvement, some speaking of "great," "considerable," "decided," "marked," improvement. One says: "Certainly does not spoil." Two say: "About the same." Six do not reply. One person remarked to me that, "the fire turns its face to you instead of its back."

Question 4.—Does the Fire Give out Less or More Heat?

Fourteen say: "More heat." One: "Certainly not less." Five: "About the same." One: "Not so much." One: "Some fires more, some the same, some less." Five give no reply.

Question 5.—Does the Kitchen Boiler heat as well as Before?

Nine say: "Better." Eleven: "As well." One: "Cannot say." One: "Varies unaccountably." One: "Doubtful." Five: "Have no boiler."

Question 6.—Does the Oven Heat as well as Before ?

Eighteen reply: "Better." Ten: "As well." Two: "No oven."

Question 7.—Is there Less Dust in your Rooms ?

Twenty one reply Yes, and of these fourteen speak emphatically "much less" &c.

II.—DIMINUTION OF SMOKE.

This, the second of my three points, is the most difficult to prove. There are, however, strong reasons for the belief that soot and smoke are very materially diminished by the use of the economiser.

In the first place, if three tons of coal do the work of four it is a reasonable presumption that there is at least a fourth less of smoke produced in a given time But, if it can be shown that during this period of time the three tons are being more perfectly consumed, it is surely fair to infer still further that the aggregate diminution of smoke is greater than is represented by the amount of coal saved.

My attempts to prove this point by exact observation have not so far succeeded. In two instances in which the sweeping of a chimney was compared over equal intervals, the amount of soot in the economised chimney was exactly the same as the amount in the chimney without an economiser. This fact, however, does not necessarily tell against my point, as it may be that the slower draught resulting from the economiser allows the chimney to strain off a greater proportion of the soot.

The question no doubt might be brought to a crucial test by photography, but I have not had time to work out such a means of investigation. My own house supplies confirmatory evidence in several ways. My impression is that much less smoke issues from my chimneys than formerly. The coachman tells me that the glass roof of the shed in the stable yard does not become darkened with soot as was usual at this time of year. The leaves of the plants in my greenhouse are now wonderfully free from smits, and formerly they were almost "smothered" during the winter months. The servants state that the toilet cover in one of their bedrooms, which used to be changed every week on account of the soot, now lasts three weeks. These points tend to show that, at any rate in the case of detached houses, the chief part of the soot which annoys us comes from our own chimneys, and not from those of our neighbours. (*Vide* plate. X.)

Question 8.—Do you observe any diminution of soot in the flues and neck of the Kitchen Chimney?

Seventeen reply: "Less soot and smoke,"—and of these twelve speak emphatically of "much less," &c.

Twelve reply: "No diminution observed."

III.—COMPLETE COMBUSTION OF COAL AND CINDER.

This point is perhaps the most striking of all. *It is possible to abolish cinders. It is possible to burn good Yorkshire coal to powder.* At my lecture I exhibited a box containing the product of the burning, for two months, of a small kitchen fire, which heats the hot water for the lavatories at my chambers

in Cookridge Street. The ash weighs 29 lbs., or half-a-pound per day for 18 or 20 lbs. of coal; equal to 2½ per cent of residue. The scientific chemical residue is 2·8 per cent. The smaller residue is probably to be explained by loss in fine dust carried up the chimney.

The ash from the kitchen fire at home, for seven days in October, weighed 9 lbs. for 504 lbs. of coal; of the same fire, for 8 days in much colder weather in November, was 14 lbs. for 666 lbs. of coal. On one day in November, when much hot water was needed, the fire was burnt in the old way without the economisers, and consumed 127 lbs. of coal and produced 13 lbs. of cinder and ash. Thus the economised fire produces 2½ per cent of ash; the ordinary fire 10 per cent. of cinder and ash.

Question 9.—What Effect has the Economiser on the amount of Cinder and Ash?

Twenty-six give the strongest testimony as to the reduction to ash.

One says: "Amount now for a week the same as formerly for a day—one bucketful."

Another says: "Well under grate fills in a week with an ash as fine as powder."

Three give no reply. One thinks there is no difference.

Let us think for a moment what this means. That for 100 tons of coal thus perfectly consumed, instead of 10 tons we ought only to put three tons into our ashpits, and if, at the same time, we burn a fourth less of coal, little more than two tons instead of 10; a *possible* saving to the town of four-fifths of the cost of emptying ash-pits, and a consequent saving of rates.

Moreover, it is said that ashes free from cinders would be more valuable to farmers than the present cinder-laden contents of our ash-pits.

Radiant versus Convected Heat.

Much is written now-a-days about converting coal into gas, doing away with the open fire-place, and heating with warmed air, *i.e.* by convected heat. Shall we not do better if we improve the radiating power of our fire-places, or use gas so as to produce radiant heat, as in the gas stoves just brought out by Mr. Fletcher? Surely radiant heat far surpasses in comfort and healthiness convected heat, and I hope, that with scientific treatment, will prove not less economical.*

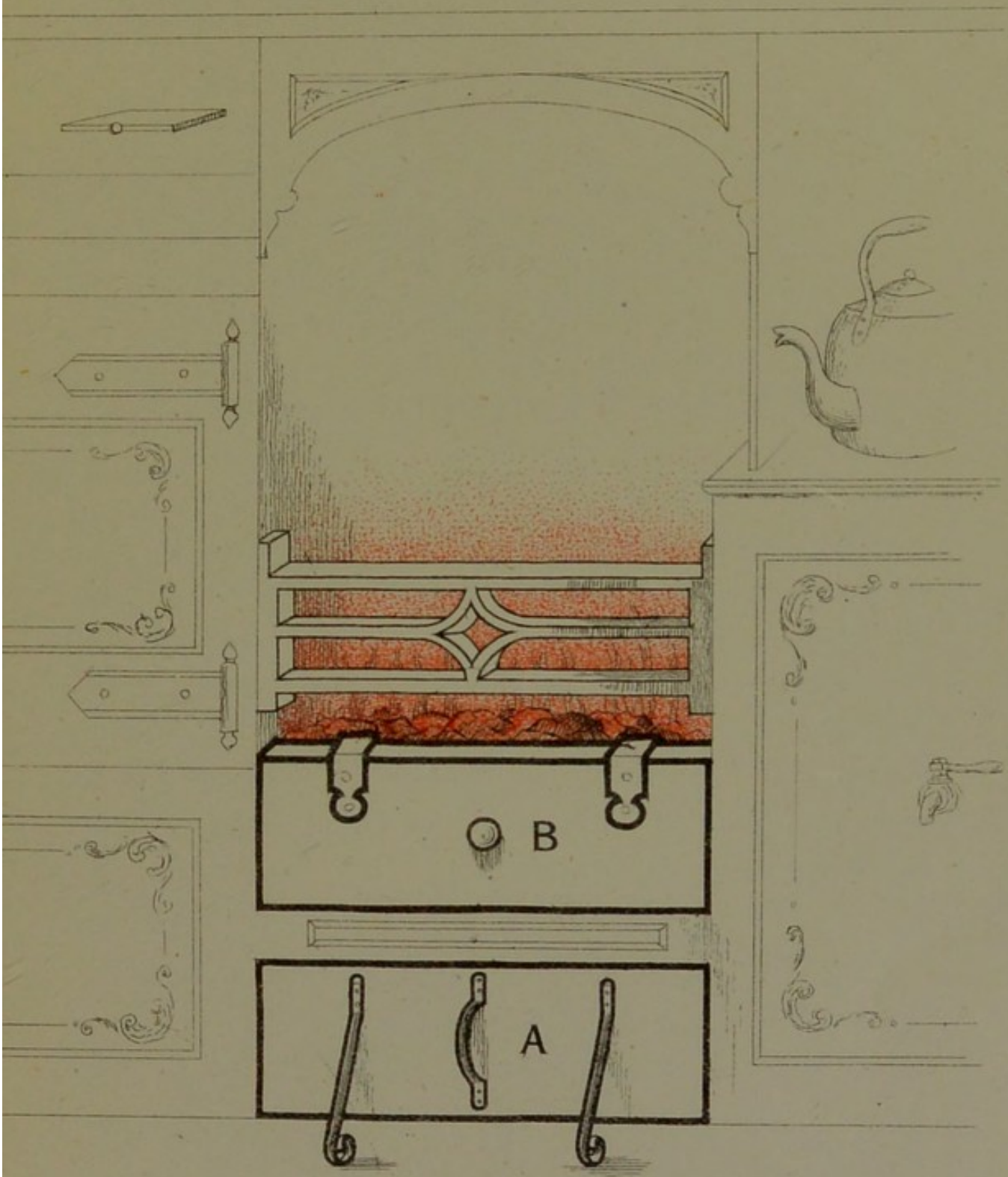
* On radiant and convected heat, read Mr. Fletcher's pamphlet on Economy of Fuel.

PLATE I.

Kitchen Range.

The *Economiser* has been chiefly tested in the open range; but it succeeds also in ranges of the Leamington type, and generally in cottage ranges. The *Front-damper* should be used always in summer and warm weather, except when the front of the fire is needed for cooking; should always be put on at night; and seems to be of use when there is rapid call for hot water.

PLATE I.



Kitchen Range, shewing

A. Economiser. (See page 13.)

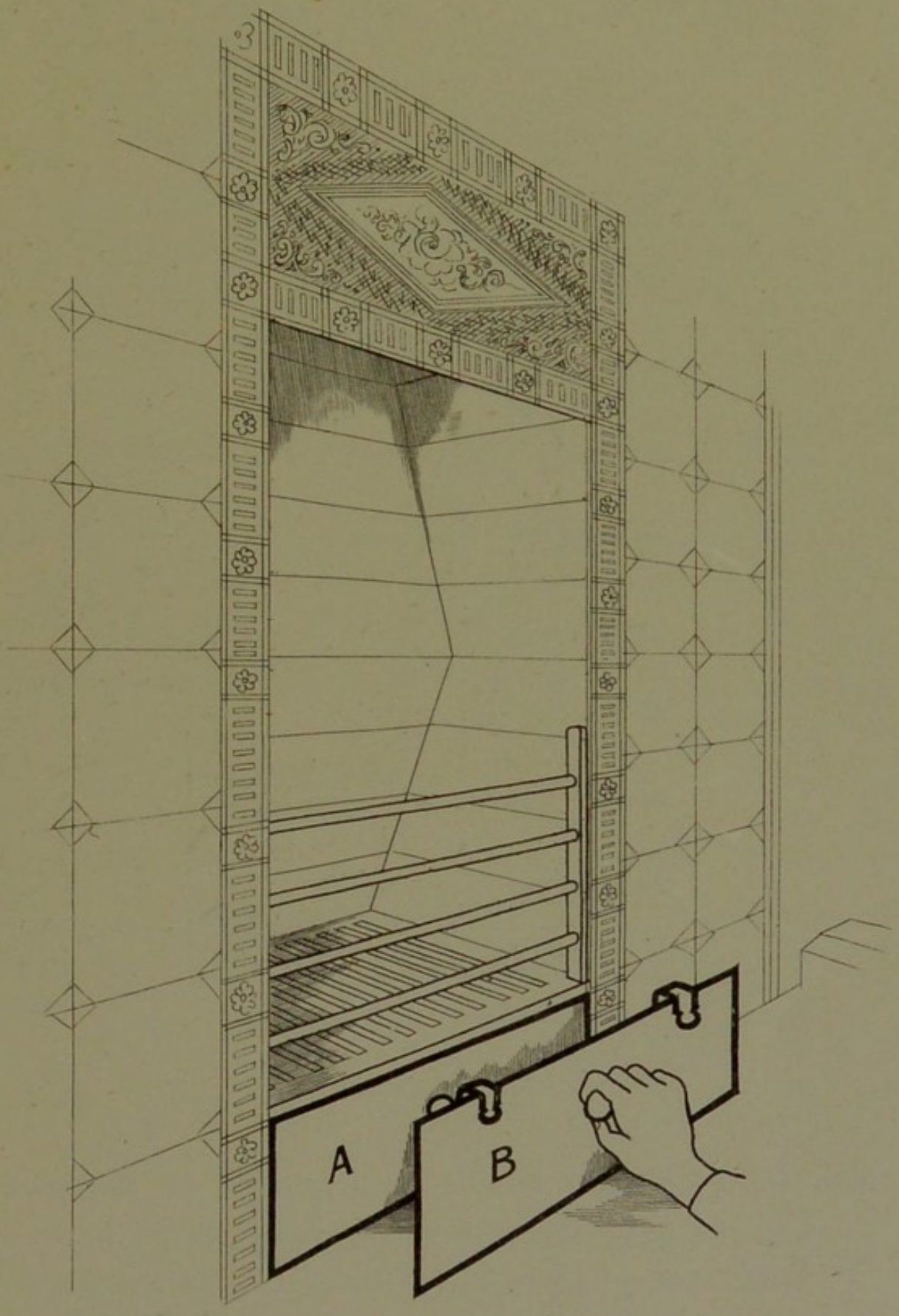
B. Front Damper. (See page 16.)

PLATE II.

A Model Bed-room Fire-place.

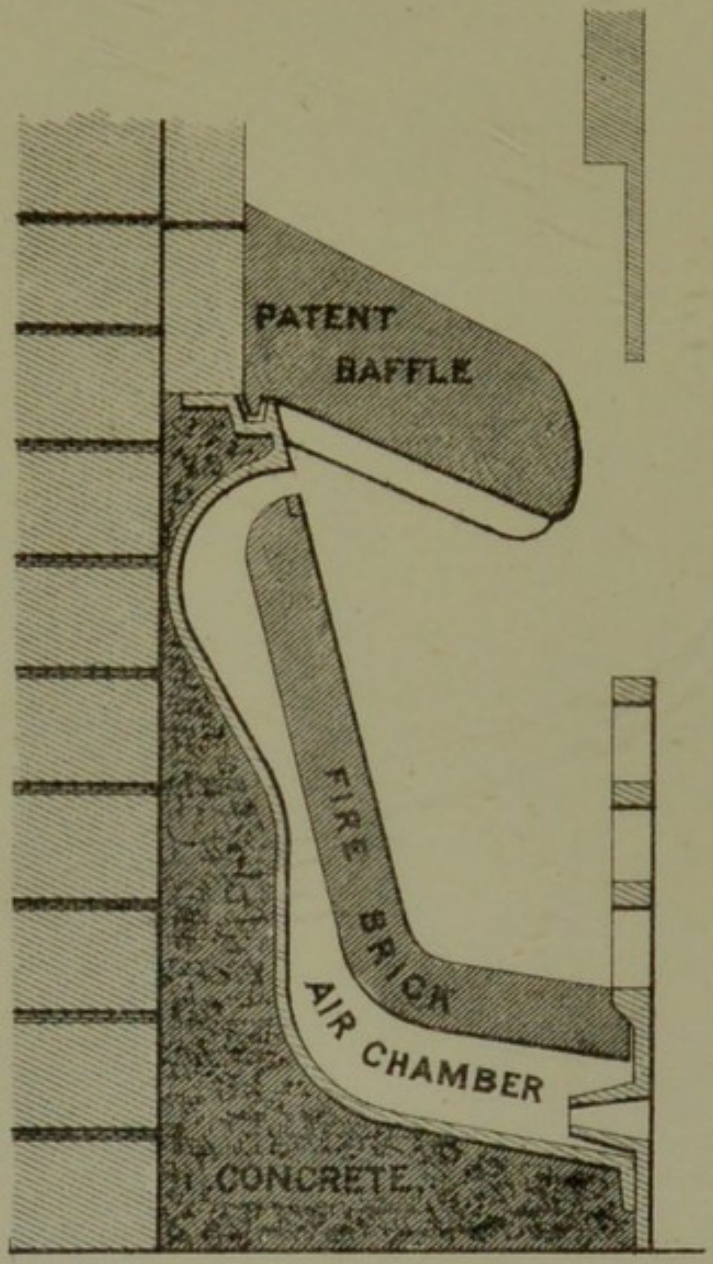
This Plate illustrates all the principles laid down (page 12) for the construction of the fire-place; fire-brick sides, with fire-brick back leaning over the fire (Milner's); narrow front bars, removeable, after the pattern of the Parson's grate; grating with narrow slits; chamber under the fire closed by "economizer" A; the "front damper" B, which can close the lower two-thirds of the front of the fire at night, or at any time when a slow fire is needed.

PLATE II.



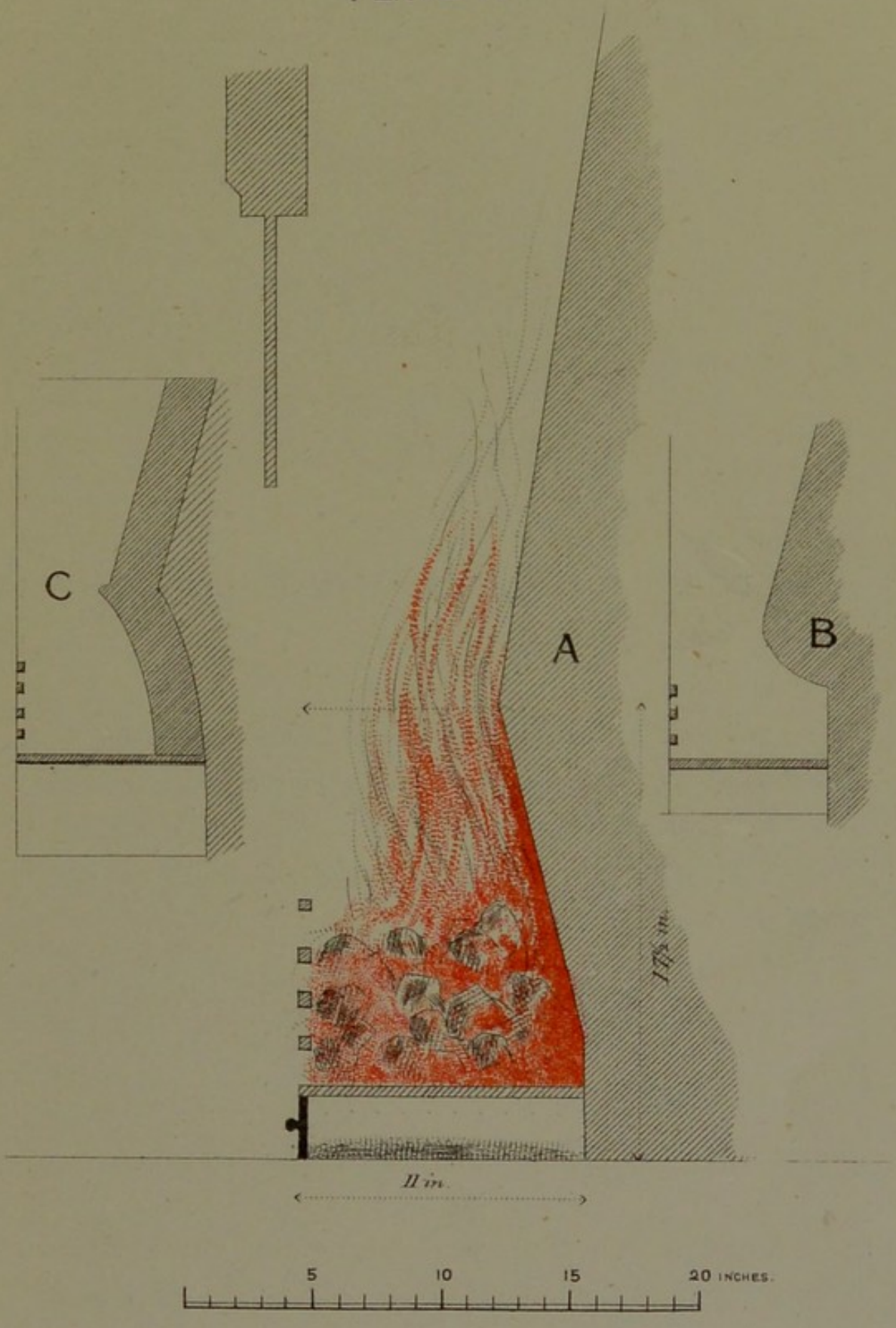
Bed-room Fire-place.

PLATE III.



The Range with a Patent Baffle, made by Barnard and Bishop, illustrating the principle of a fire-brick roof or arch above the fire, as a means of consuming smoke.

PLATE IV.



A.—Combination of Parson's Grate and Economiser, with "Milner" back.

B.—Nelson and Sons' "Rifle" back.

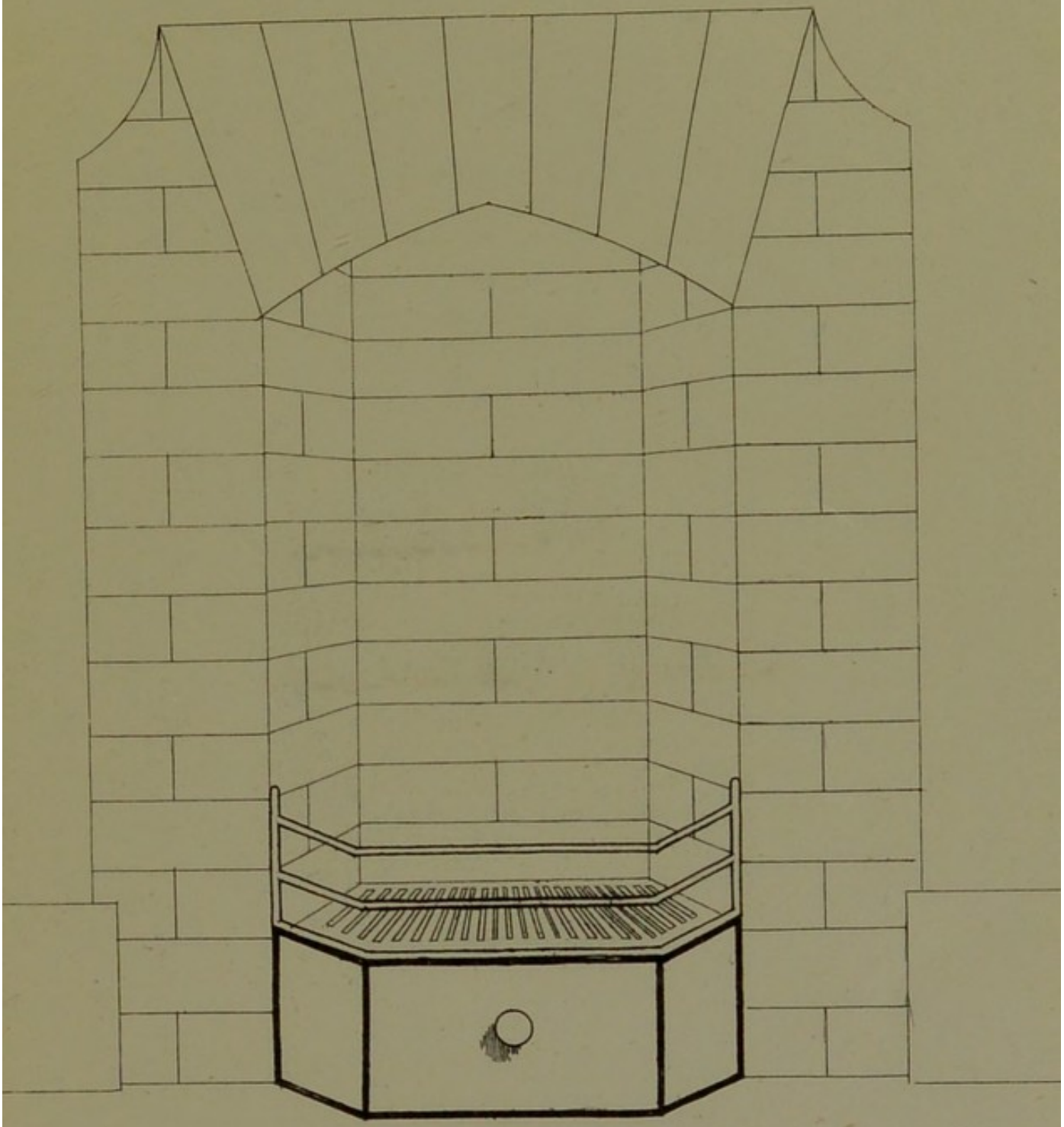
C.—"Galton" back.

PLATE V.

Bed-room Fire-place with Economiser.

This neat and simple fire-place is to be seen in the bed-rooms at the St. Pancras Hotel, made of red brick, moveable front bars, and a grating. With the addition of a Milner, or Galton, or Rifle back, and an Economiser, it could not easily be surpassed.

PLATE V.



Simple form of Bed-room Fire-place, with Economiser.

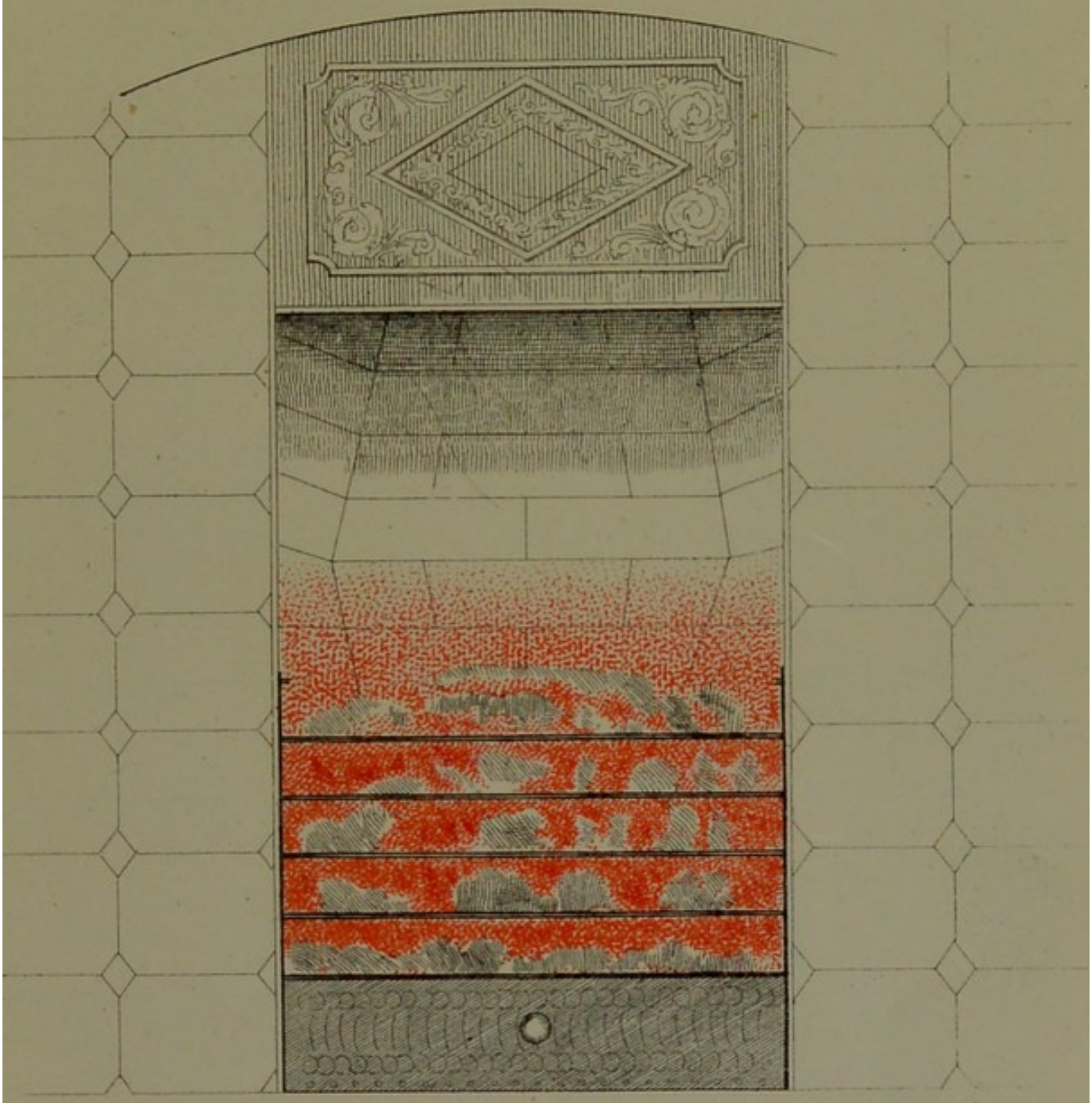
PLATE VI.

A sketch "from Life."

Waiting Room at a Railway Station, 4 p.m.

"Fire turning its back to you."

PLATE VII.



A sketch "from Life."

My Bed-room Fire.

"Fire turning its face to you."

PLATE VIII.

The Disc poker.

This illustration is given as a guide to any ironmonger who wishes to make the disc poker.

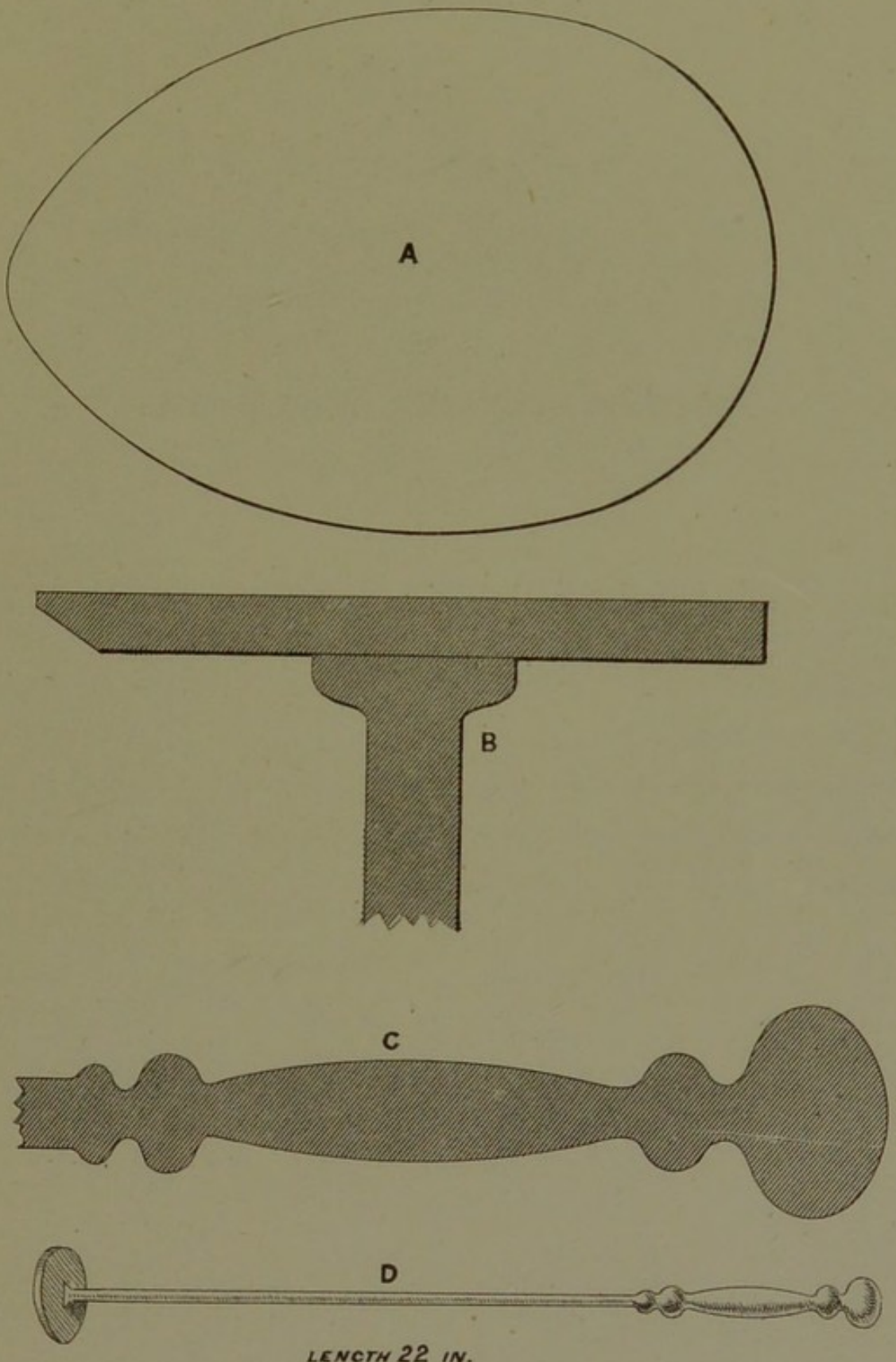
A.—Size and shape of disc.

B.—Section of disc, shewing the bevel at the smaller end to facilitate the breaking of coal.

C.—A convenient form of handle. N.B.—Handles of fire-irons are often made as inconvenient and as uncomfortable as possible. Actual length, 4½ inches.

D.—The disc poker. Length 22 inches.

PLATE VIII.



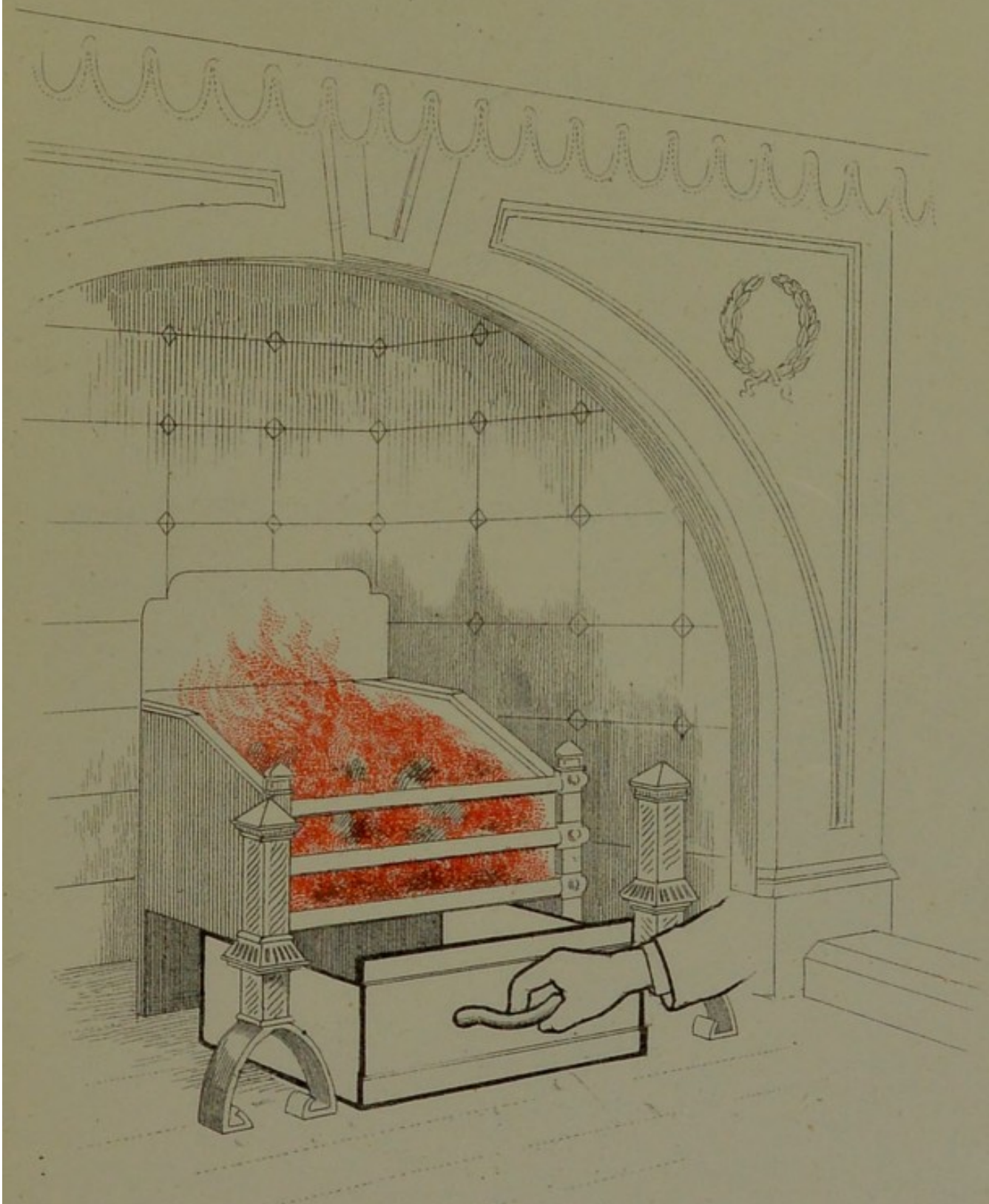
The Disc Poker.

(See page 17.)

Economiser for Dog-Grate.

The fire in a dog-grate can be improved by an Economiser to which sides are added. Such a fire is not of the best, because of the want of fire-brick. It is my intention to try an Economiser with tiled front, and fire-brick in the sides, so as to increase the storage of heat below the fire. A dog-grate violates the first principles of a good fire-place in having much iron and very scanty fire-brick.

PLATE IX.



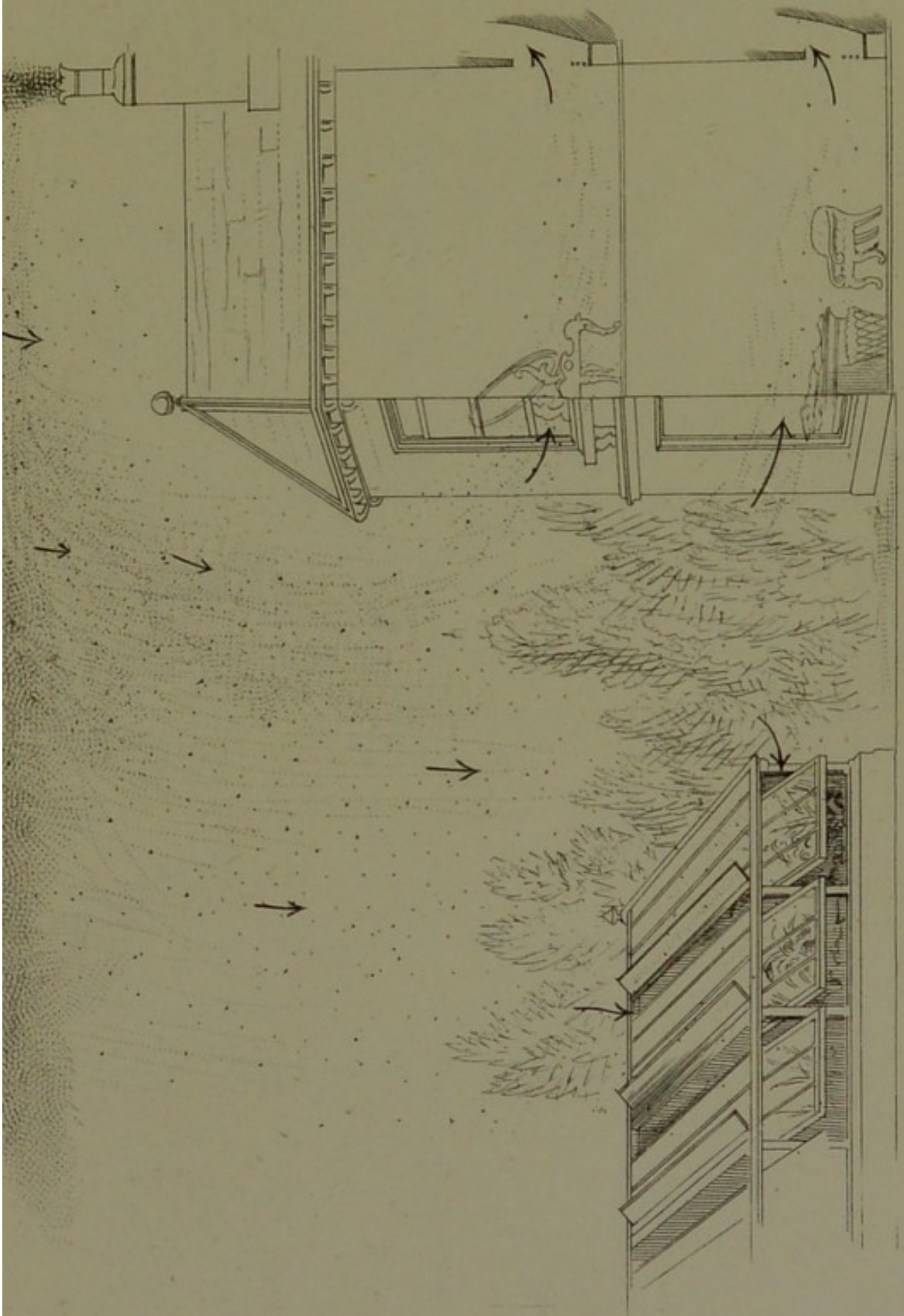
An Economiser suitable for a "Dog Grate."

PLATE X.

Our own chimneys our worst enemies.

If any one doubts this, let him observe newly-fallen snow on the lee side of a low chimney; or the smits falling like "black snow flakes" from a newly-mended kitchen or laundry fire, or the leaves of plants in a greenhouse where the house chimneys are to windward.

PLATE X.



"How we foul our own nest."—"Our own chimneys our greatest enemies."

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