(No Model.)

C. S. BURTON.

LOCOMOTIVE SMOKE STACK.

No. 570,083. Patented Oct. 27, 1896.

Fig. 2.

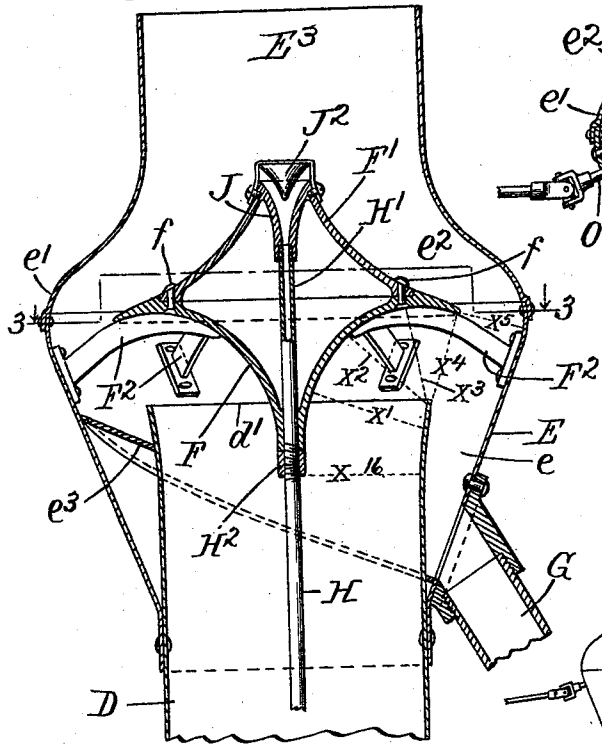


Fig. 4.

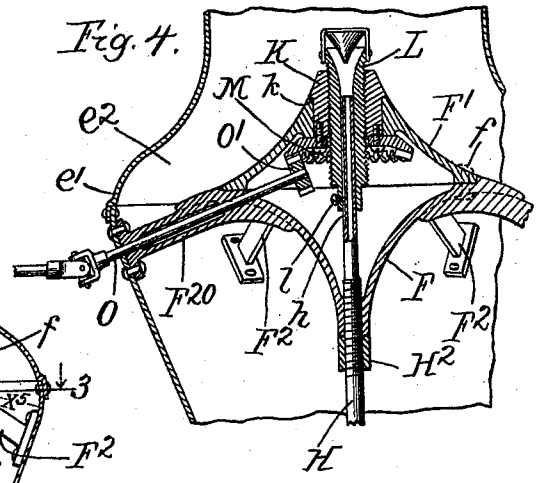


Fig. 1.

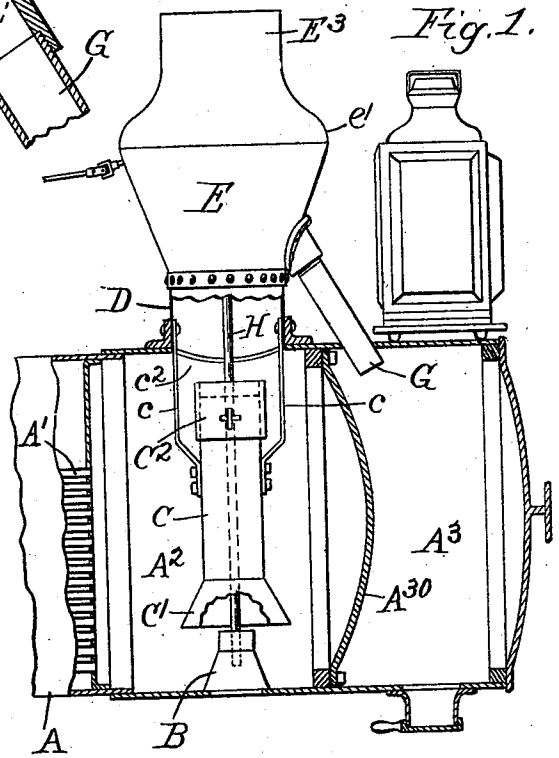
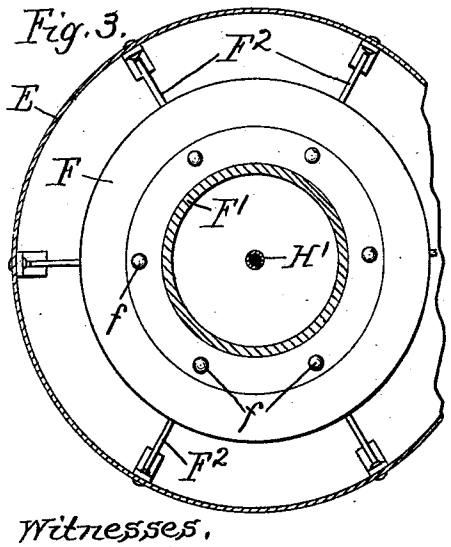


Fig. 3.



Witnesses.
E. T. Wray.
Jean Elliott

Inventor.
Chas. S. Burton

UNITED STATES PATENT OFFICE.

CHARLES S. BURTON, OF OAK PARK, ILLINOIS.

LOCOMOTIVE SMOKE-STACK.

SPECIFICATION forming part of Letters Patent No. 570,083, dated October 27, 1896.

Application filed December 9, 1895. Serial No. 571,508. (No model.)

To all whom it may concern:

Be it known that I, CHARLES S. BURTON, a citizen of the United States, residing at Oak Park, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Locomotive Smoke-Stacks, which are fully set forth in the following specification, reference being had to the accompanying drawings, forming a part thereof.

This invention is an improvement upon locomotive smoke-stacks of the class in which cinders or other solid matter are precipitated by deflection in the passage of the smoke and gases through the stack, so that the latter emerge devoid of solid matter.

It consists in specific features of construction set forth in the claims.

In the drawings, Figure 1 is a vertical longitudinal section of the forward end of a locomotive-boiler having my improved smoke-stack, the upper portion of which, containing the devices which distinguish my invention, is shown in side elevation only. Fig. 2 is a vertical section, on an enlarged scale, of the upper portion of my improved smoke-stack, which is shown in side elevation in Fig. 1. Fig. 3 is a horizontal section at the line 3 3 on Fig. 2. Fig. 4 is a detail vertical section of the deflector and portion of the stack-shell, showing a modified form of a nozzle designed to assist the draft, the modification consisting in devices for adjusting the nozzle to vary the draft produced.

A is a boiler, in which the flues are represented at A′, the smoke-box at A^2, and the ordinary extension-front at A^3, such extension-front being partitioned off from the rear portion of the smoke-box by a smoke-tight partition A^{30}.

B is the exhaust-nozzle, which discharges under the flaring mouth C′ of a so-called "petticoat-pipe" C, which is suspended by straps *c c* from the stack D and has at the upper end a telescoping extension C^2 for the purpose of adjusting its upper terminal nearer to or farther from the bottom or entrance-mouth of the stack, between which and the upper edge of the petticoat-pipe there will always be left an annular space of suitable width to cause the exhaust-blast to draw smoke not only through the lower flaring mouth C′, which will take the smoke chiefly from the lower portion of the flues, but also through the annular space c^2 between the upper margin of the petticoat-pipe and the receiving-mouth of the stack, the upper portion of the flues being served chiefly by the draft thus produced through such annular space.

The structure thus far described, while not distinctively a part of my invention, bears relation to it in that by the use of my invention it is made possible to produce an equalized draft through all the flues by means of the petticoat-pipe, short nozzle, and adjustable telescoping terminal of the petticoat-pipe without sacrificing any opportunity or facility for arresting sparks by causing deposit of solid matter.

The distinguishing features of my invention relate to the upper portion of the stack, which will now be described.

The stack comprises a lower portion or uptake-pipe D, which is substantially cylindrical, but may be slightly flared or expanded at the upper end at D′, and a portion E, which I term the "head," and which contains and supports the deflector F and parts accessory thereto. The head E is, in general as to its lower part, an inverted-cone-frustum shell secured at its lower narrower base outside the portion D of the stack at considerable distance below the upper end of the latter, whereby there is formed within said head and around the upper and intruding portion of the cylindrical part D an annular chamber *e*. The widest portion of the head E at *e′* is several inches above the top of the portion D, and from that point the head narrows, preferably, somewhat in the form shown, that is, in flowing curves, inclosing the passage e^2, rendered annular by the presence of the deflector F hereinafter described, and it ultimately terminates in a substantially-cylindrical portion E^3. The deflector F F′ is, in general, of double conical form, the lower portion F being conical, with the apex of the cone downward at the center of the stack, the conical surface, however, being, in axial section, curved concavely downward. The upper portion F′ has, primarily, only the function of serving as a roof or water-shed for the deflector, although, as represented in the drawings and preferably constructed, it also supports a nozzle through which live or

exhaust steam may be discharged within the cylindrical terminal E^3 of the stack to assist the draft. It is convenient to construct the deflector in two parts F F', the lower part F being formed with arms or feet F^2, by which the deflector is secured and supported upon the head E. From the lower portion of the chamber *e*, at any convenient point, as illustrated, at the forward side, a discharge-pipe G leads to any convenient receptacle for cinders. A false bottom e^3 may be provided in the chamber *e*, inclined upward from the mouth of the pipe G to the opposite side of the chamber around the stack-pipe D to cause the solid matter to slide easily into said discharge-pipe. This false bottom is probably not absolutely essential, because, in any event, the cinders having opportunity for escaping at the pipe G will probably remain lodged in the chamber only until the surface of the accumulated quantity has such inclination as to cause the subsequently-deposited particles to roll or slide down to the mouth of the pipe.

Before going further into the description of the detail structure of the deflector and nozzle, associated therewith, the operation of the device may be described.

The natural draft or the artificial draft produced by the exhaust-blast carries the smoke, together with the solid particles which it usually contains if combustion is imperfect, forcibly up the cylindrical portion or uptake D of the stack against the downwardly-concave surface of the deflector F, whereby the solid particles are pulverized and the entire blast and especially the solid particles are deflected outwardly. The flare or expansion of the upper mouth of the uptake-pipe D must not be such as to give opportunity for solid particles which may chance to be ejected along the flared margin, and which would thereby have a direction substantially tangential to the inner surface thereof, to pass out without encountering the deflector F, that is, the deflector must extend at least far enough to intercept all tangents of the inner surface of the discharge-mouth of the uptake-pipe, so that all solid particles ejected forcibly from the uptake-pipe will strike the deflector and be thrown aside into the receptacle. Since the purpose and necessity for flaring the mouth of the uptake-pipe is to compensate for the diminution of the smoke-passage by the intrusion of the lower point of the deflector F thereinto, it will be understood that such lower intruded point must not have too great an angle. On the other hand, if the whole surface of the deflector F were no more inclined than the intruded portion at the lower point the deflection would not be sufficient to precipitate solid matter, or if the deflector were not at all intruded into the uptake-pipe, but commenced above it and were made strictly conical with a wide angle, so as to abruptly deflect the current over the top of the uptake, the effect would be to turn the whole current outward with like abruptness, giving to the portion emerging adjacent to the edge of the uptake-pipe an outward direction equally as if the uptake-pipe were continued and flared from that point. Such abrupt deflection of the current would produce very marked back pressure, with all the disadvantages incident thereto, and besides would necessitate very great extension of the deflector in order to completely intercept all solid matter. Such abrupt deflection and consequent back pressure and wide spreading of the solid matter, necessitating wide extension of the deflector, is avoided by commencing the deflection gradually, as by intruding the deflector into the uptake-pipe and making its deflecting-surface at such intruded portion very slightly divergent, thereby necessitating very slight flaring of the mouth of the uptake-pipe to compensate for the diminution of area, and increasing the angle of deflection gradually until the entire change of direction of the surface of the deflector has amounted to nearly ninety degrees, that is, from vertical to horizontal. This results in a deflector vertically curved in axial section, as shown in the drawings, and such deflector, being extended, as shown, far enough so that it intercepts all tangents to the inner surface of the discharge-mouth, will intercept all solid matter which can be discharged from the uptake-mouth. The curvature of the deflector F is at the same time calculated so that all solid particles striking it will be deflected in such direction that they will strike the inclined wall E of the head at an angle which will cause them to be again deflected downward into the receptacle *e*, or, at all events, to be positively arrested so that they will slide downward, and will not be deflected upward so as to pass out at the top of the stack. The gaseous matter, on the other hand, although deflected by the curved surface of the deflector F, having much less momentum than the solid particles, and having opportunity to expand as it passes over the edge *d'* of the pipe D, will be carried out with the draft, being again deflected by the outer wall of the head and compelled to pass upward because no sufficient escape is provided downward. The result is that the solid matter is thrown out from the midst of the gaseous matter by virtue of its greater density and consequently greater momentum, so that the gaseous matter passes off while the solid matter remains in the receptacle *e* and escapes downward through the pipe G to an ultimate receptacle which may be provided. The difficulties experienced in devices employing the deflecting principle heretofore for like purpose have been, first, that the retardment of the smoke current caused by the deflection produces so great a degree of back pressure in the smoke-stack and upon the exhaust-nozzle, and thence back to the engine, that in order to maintain the proper draft greater pressure of steam is necessary and a larger amount of exhaust-

steam, which necessitates longer cut-off and consequently greater consumption of steam by the engine. It is very important, therefore, in providing for deflection to precipitate the solid matter, to provide also against back pressure in the smoke-stack. In addition, therefore, to avoiding too abrupt deflection of the current by making the deflector of the curved form shown, I make the dimensions such as to contribute to diminution of pressure. In the first place, as above described, I design and prefer to flare the upper end of the cylindrical portion of the stack at D′, as shown, sufficiently to compensate, and preferably somewhat more than compensate, for the space occupied by the lower end of the deflector which protrudes down into the upper end of said cylindrical portion. Furthermore, the curve of the lower side of the deflector F is such with respect to the upper margin of the cylindrical portion D that the capacity of the stack increases in the path of the smoke, thereby permitting an expansion, and consequent diminution of pressure, steadily from the point where the deflection first commences to the point at which the deflection is complete, and the gaseous matter resumes a nearly direct upward path. This increase of capacity I have indicated on Fig. 2. If, at the point indicated by the line x, the capacity be that of a sixteen-inch cylinder, as is indicated by the number "16" marked on that line, it has increased at the line x' to seventeen and one-half, at the line x^3 to twenty-four, and at the line x^4, where the deflection necessary for precipitation is completed, it is twenty-eight. From this point the expansion may be little or nothing to the line x^5, where the gases have recovered their nearly direct discharge movement. From this point outward the capacity may even be diminished without detriment, because the normal upward draft and the proximity of the discharge-mouth tend to assist; and, furthermore, I prefer to provide a nozzle at the upper apex of the deflector, through which escaping steam may supply a supplemental force to restore whatever draft may have been lost during the deflection. In practice, however, the back pressure or resistance to outward movement of the smoke due to the deflection may be more than compensated by the form and dimensions allowing for expansion and relief of pressure, and this is further assisted by some tendency to condensation due to the cooling experienced particularly after the gases pass the line x^4 and for the first time strike the wall of the head at a portion which is exteriorly directly exposed to the outer air. The condensation at this point will relieve back pressure as much as or more than it has been relieved by the increased capacity progressively up to that point, and for this reason I have not designed any marked increase of capacity from the line x^4 to the line x^5. Any actual condensation resulting in moisture which will flow down into the receptacle e serves the further desirable purpose of extinguishing any live sparks, and it is designed and expected, and in accordance with experience with the device, that sufficient condensation will occur to completely extinguish all fire and cause the cinders to be delivered through the pipe G in an entirely harmless condition, even if a receptacle should not be provided for them.

As above stated, I prefer to provide for a supplemental steam-jet to be discharged through a nozzle at the upper apex of the deflector within the cylindrical discharge-terminal E^3 of the stack, and for that purpose I lead the steam-pipe H from the center of the exhaust-nozzle directly up through the center of the petticoat-pipe and through the center of the stack into the center of the deflector at its lower apex and through the same to the nozzle J, which is formed as the upper terminal of the roof or water-shed F′ of the deflector. A convenient mode of construction is that shown in Fig. 2, wherein, the deflector being made in two pieces F and F′, adapted to seat one upon the other and be united by rivets, as at f, a section H′ of the pipe H is inserted through the lower apex of the deflector and screws into the lower end of the nozzle J, which constitutes the terminal of the upper member F′ of the deflector, and a coupling H^2, screwed onto the protruding lower end of the pipe-section H′, serves not only as the means for uniting it to the lower portion of the pipe H, but also serves as a stop and clamping-nut by which the upper section H′ of the pipe is adapted to serve as a tie to bind the two portions F and F′ together. J^2 is a spreader, which may be employed within the mouth of the nozzle to cause the steam-jet to be discharged in conical form to increase its draft-producing form.

The amount of draft requisite to accomplish all the desirable results and give the locomotive the best steaming capacity varies with different fuels, and in order that the engineer may readily adapt the device to the fuel in this respect without materially altering the force of the blast that is deflected to precipitate the solid matter I deem it desirable to make the nozzle at the upper apex of the deflection adjustable vertically, so that it may deliver its conical jet of steam at varying distances from the discharge-mouth of the stack, and in order to give such jet greater draft-producing power such adjustable nozzle is set deeper, that is, farther, from the upward-discharge mouth of the stack, and to diminish its power it is raised more nearly to the level of the discharge-mouth. Such adjustable nozzle is shown in Fig. 4. In this form the two parts F and F′ of the deflector may be secured together solely by the rivets f. The upper end F′ of the deflector has a central aperture in which is seated a sleeve K, having a marginal flange or shoulder k, which stops on the upper edge of the part F′. This sleeve is interiorly threaded and the nozzle L is screwed through it, said nozzle

being threaded substantially its entire length for that purpose. The steam-pipe H is inserted up through the lower apex of the deflector F and into the central bore of the nozzle L, which it should fit closely, but so as to permit the nozzle to slide freely on it. The pipe has a longitudinal groove *h*, and a pin or screw *l* set through the nozzle protruding into such groove serves as a feather to prevent the nozzle rotating with respect to the pipe, while it is permitted to slide thereon. It will be perceived that if the sleeve K is rotated in its bearing in the part F′ the nozzle will be moved longitudinally up or down, according to the direction of rotation. To provide means for such rotation, I pin fast to the lower end of the sleeve K, within the inner chamber of the deflector, that is, under the roof or water-shed F′, a gear M, whose hub serves as a stop to prevent the sleeve *k* from moving longitudinally. One of the arms or limbs F^2 by which the deflector F is mounted on the head E is made tubular and is represented at F^{20} on Fig. 4. Through this tubular limb a shaft O extends, obtaining bearing therein, and within the chamber of the deflector it carries a pinion O′, which meshes with the gear M and is thereby adapted to rotate the latter. The shaft O will extend out from the rear side of the stack to the cab, where it may be provided with another bearing and a crank, so that the engineer by rotating the same may adjust the nozzle without leaving the cab.

An important feature in which my improved stack is distinguished from certain other deflecting stacks is that the uptake-pipe at its upper part is protected from exterior cooling and from the liability to condensation of the exhaust-steam within said uptake-pipe and from the consequent precipitation of the condensed moisture by deflection with the solid particles, such protection being effected by the exterior shell which forms the chamber *e* around the uptake-pipe. When the deflection is inward and the receptacle is interior instead of exterior to the uptake-pipe, the uptake-pipe itself being in that case necessarily flared, its exterior surface thus increased and tending to cause great condensation so impairs the momentum of the outgoing current as to cause the smoke to emerge from the stack without any decided upward tendency, so that it is liable to settle heavily about the cab and train, instead of being ejected upward, as it should be, with sufficient force to clear the train. Furthermore, in such construction the water of condensation is precipitated in large quantity with the cinders, and the discharge through the cinder-pipe either becomes a muddy stream or, if the moisture is insufficient to make the mass flow as a liquid, it is liable to become pasty and clog in the receptacle instead of passing off, and either condition makes the problem of disposing of such solid matter in a cleanly and convenient way exceedingly troublesome. Especially is this true in view of the fact that the most convenient place for depositing the solid matter or cinders is in the space which may be partitioned off from the customary extension-front, where it is of necessity exposed to the high temperature of the partition-plate, and if the discharge consisted largely of water in addition to the cinders the danger of generating steam and developing high pressure in the space would prevent utilizing the same, whereas if the same matter can be deposited substantially dry, having been moistened merely enough to extinguish the fire, it can be safely received and carried in the extension-front.

I claim—

1. In a smoke-stack, in combination with the uptake-pipe, a central inverted conical deflector and an outer inverted-cone frustum, the latter being joined to the uptake-pipe below the discharge-mouth of the same, and provided with a discharge-opening at the lower part of the chamber formed between said exterior frustum and uptake-pipe; the deflector being in radial section concave toward the margin of the uptake-pipe and extended to overhang the same, whereby the angle of deflection is slight at the apex and increases gradually to the periphery: substantially as set forth.

2. In a smoke-stack, in combination with the uptake-pipe, a central inverted conical deflector and an outer inverted-cone frustum, the latter being joined to the uptake-pipe below the discharge-mouth of the same and provided with a discharge-opening at the lower part of the chamber formed between said exterior frustum and uptake-pipe; the deflector being in radial section concave toward the margin of the uptake-pipe; the lower point of the deflector being intruded into the uptake-pipe, and the discharge-mouth of the latter being flared to compensate for the space occupied by such intruded end, and the deflector being extended far enough to intercept all tangents to the inner surface of said flared mouth.

3. In a smoke-stack, in combination with the uptake-pipe, the inverted conical deflector above the same, the exterior shell comprising an inverted frustum joined to the uptake-pipe below its discharge-mouth and having a discharge-opening at the lower part of the chamber thus formed between said exterior frustum and the uptake-pipe, said deflector being provided with a substantially conical water-shed or roof-piece secured above the same: substantially as set forth.

4. In a smoke-stack, in combination with the uptake-pipe, the inverted conical central deflector above the same; the exterior shell encompassing the deflector at the upper part of the uptake-pipe and joined to the latter below its discharge-mouth and expanded from such junction approximately to the plane of the greatest diameter of the deflector, and thence

contracted upwardly; a steam-pipe which penetrates the apex of the deflector and a nozzle which terminates the steam-pipe within the upper reduced portion of the shell, said nozzle being adjustable in said reduced portion toward and from the discharge-mouth thereof.

5. In a smoke-stack, in combination with the uptake-pipe, the inverted conical central deflector, the shell which encompasses the deflector at the upper part of the uptake-pipe and is secured to the latter below its discharge-mouth, the deflector being provided with supports extending and adapted to be secured to the outer shell, the deflector having a water-shed or roof-piece secured above the same; a nozzle which is mounted at the apex of such roof, and a steam-pipe which penetrates the downward apex of the deflector and leads to the nozzle: substantially as set forth.

6. In a locomotive smoke-stack, in combination with the uptake-pipe, the central inverted conical deflector and a shell which encompasses the same and is contracted above the plane of the greatest diameter of the deflector to the discharge-mouth; a nozzle above the deflector and a steam-pipe communicating therewith; the connection between the nozzle and steam-pipe being such as to permit longitudinal movement of the nozzle; a rod or shaft which penetrates the stack from the exterior, and suitable connections from the shaft to the nozzle within the stack by which such shaft actuates the nozzle to adjust it longitudinally, whereby such adjustment may be effected from the exterior of the stack.

7. In a locomotive smoke-stack, in combination with the uptake-pipe, the central inverted conical deflector and the shell which encompasses the deflector, said deflector being suitably connected rigidly; a shaft which penetrates the stack and the deflector and is suitably journaled thereon and adapted to be actuated from the exterior; intermeshing gears mounted on said shaft and on the deflector respectively; a nozzle which concentrically penetrates the gear on the deflector, and a steam-pipe coaxial with and extending within the nozzle, whereby the nozzle has guide-bearings on the gear and steam-pipe, one of said guide-bearings being threaded and the other feathered, whereby the rotation of the shaft actuates the nozzle longitudinally.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Chicago, Illinois, this 31st day of October, 1895.

CHAS. S. BURTON.

Witnesses:
JEAN ELLIOTT,
JESSIE L. DAVIS.