951,994.

J. PLAYER.

LOCOMOTIVE SPARK EXTINGUISHER.

APPLICATION FILED JUNE 2, 1909.

Patented Mar. 15, 1910.

4 SHEETS—SHEET 1.

FIG. 1.

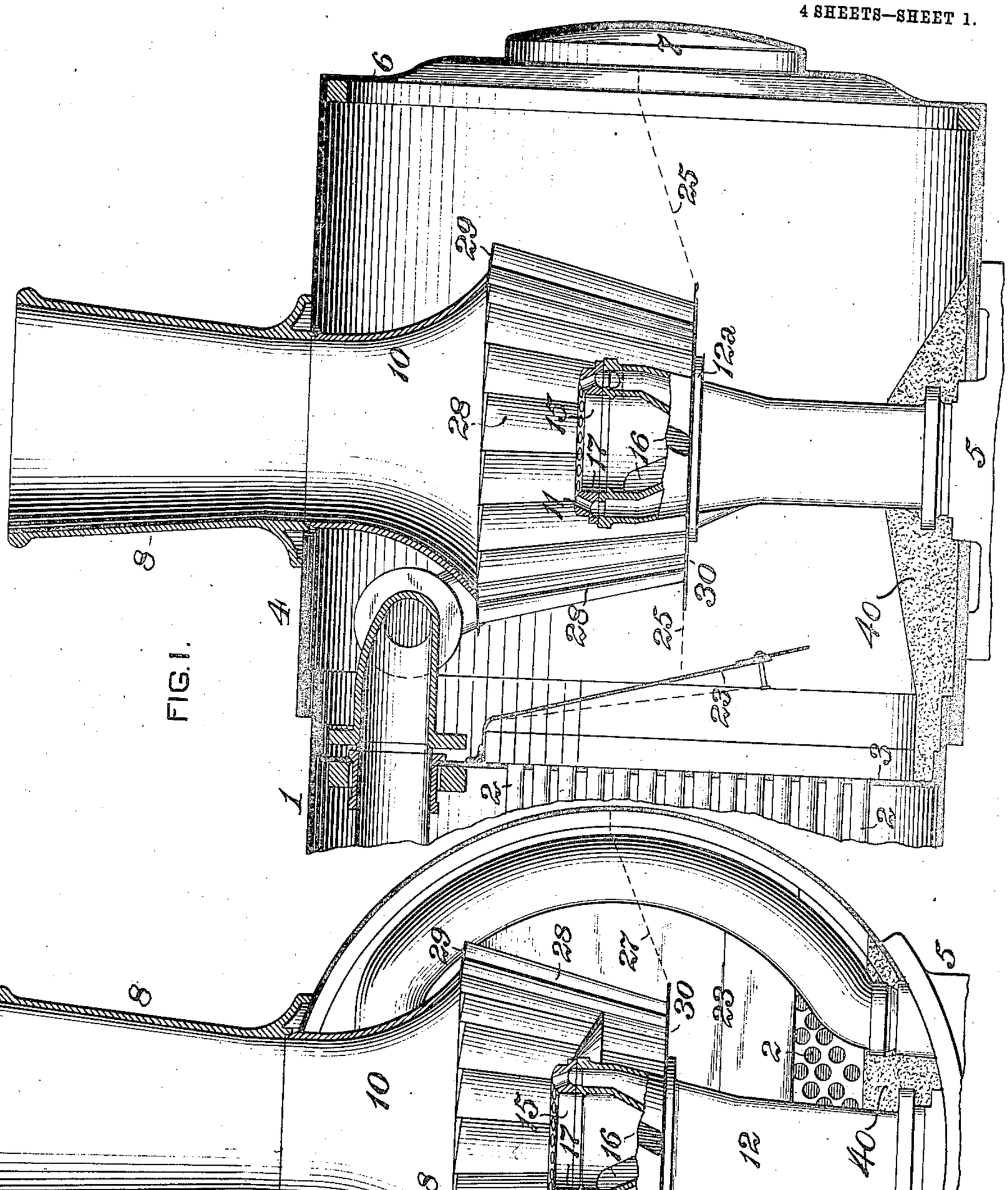

FIG. 2.

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4 SHEETS—SHEET 2.

FIG. 3.

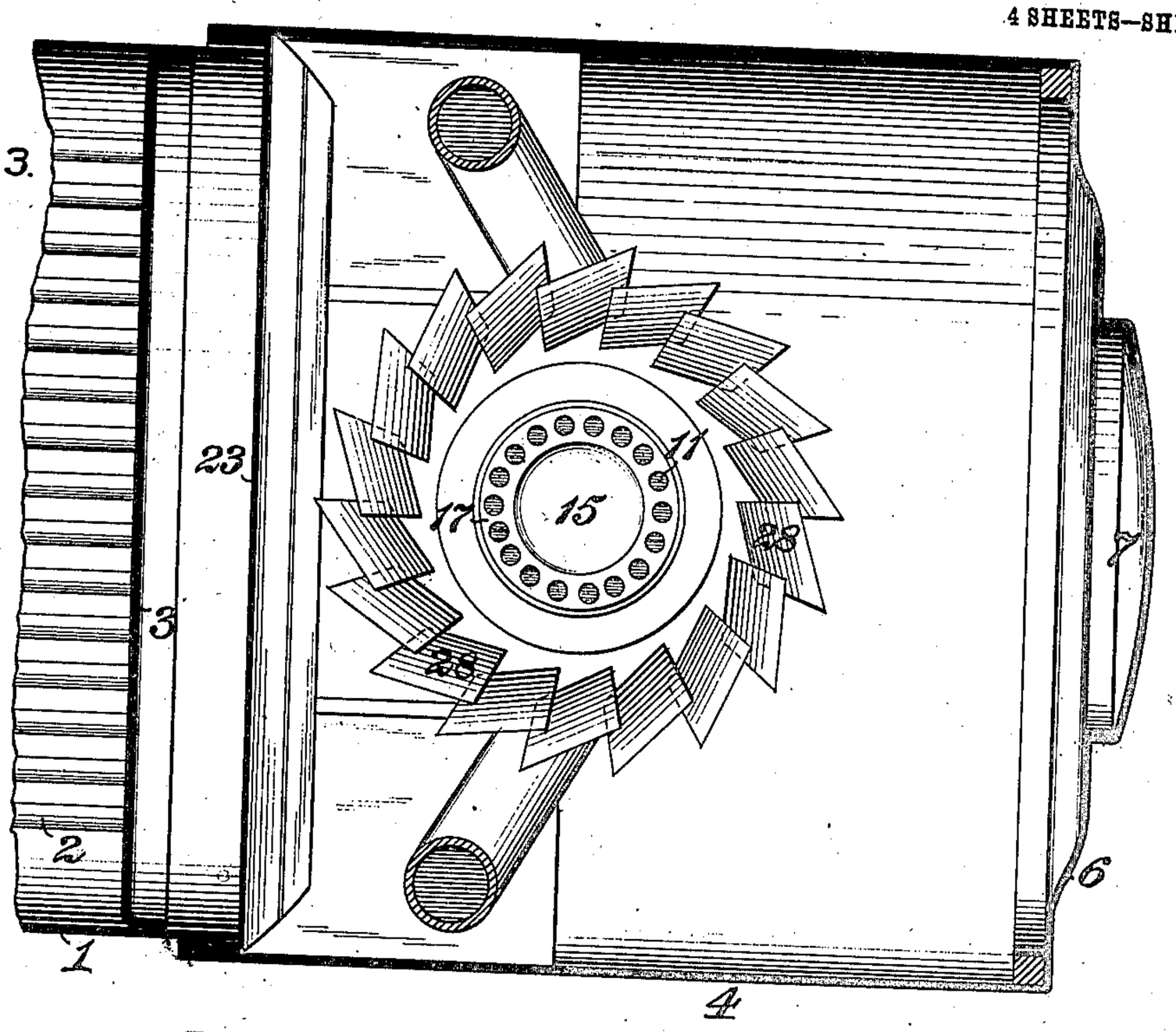


FIG. 5.

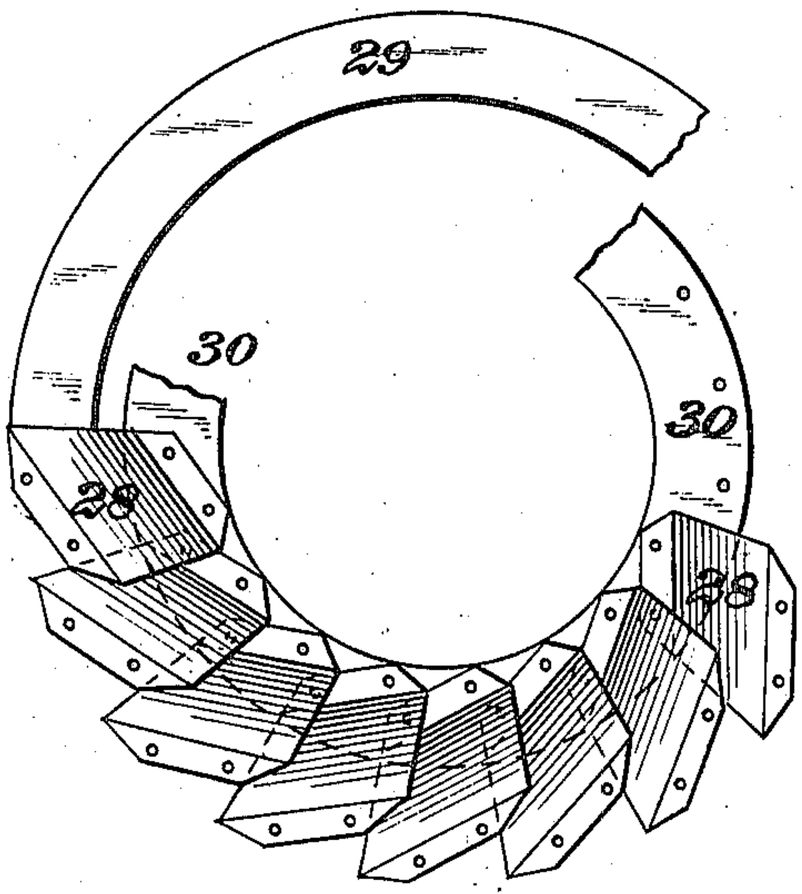
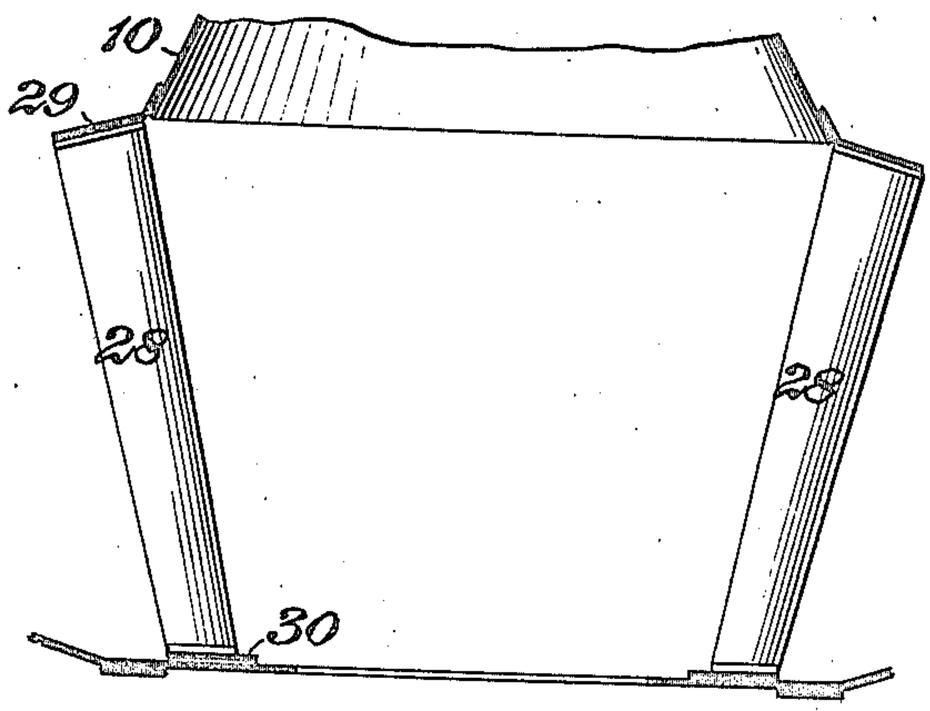


FIG. 4.



WITNESSES

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4 SHEETS—SHEET 3.

FIG. 6.

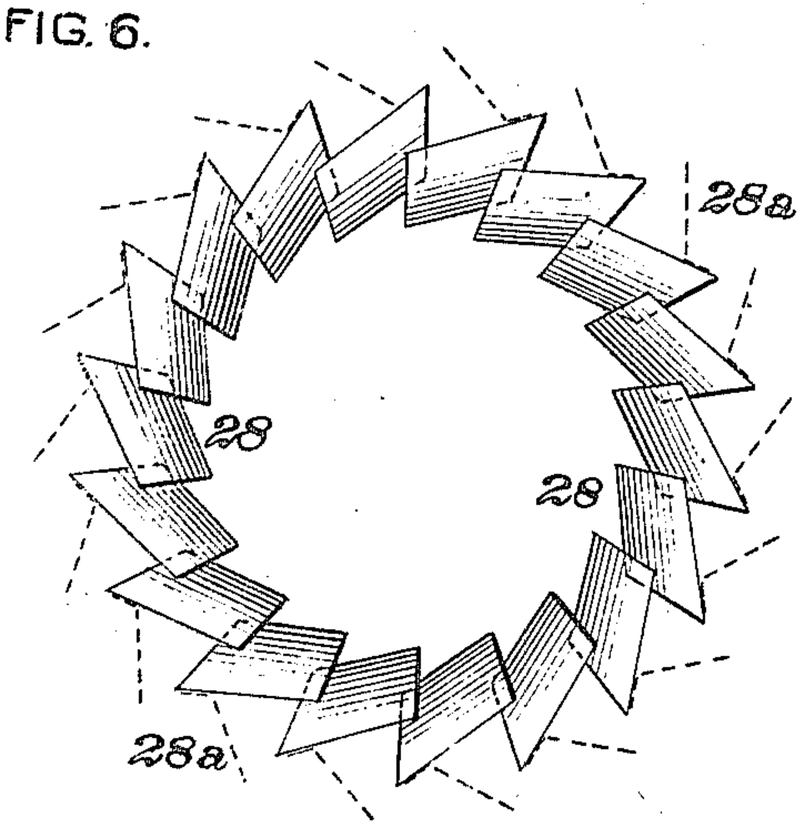


FIG. 8.

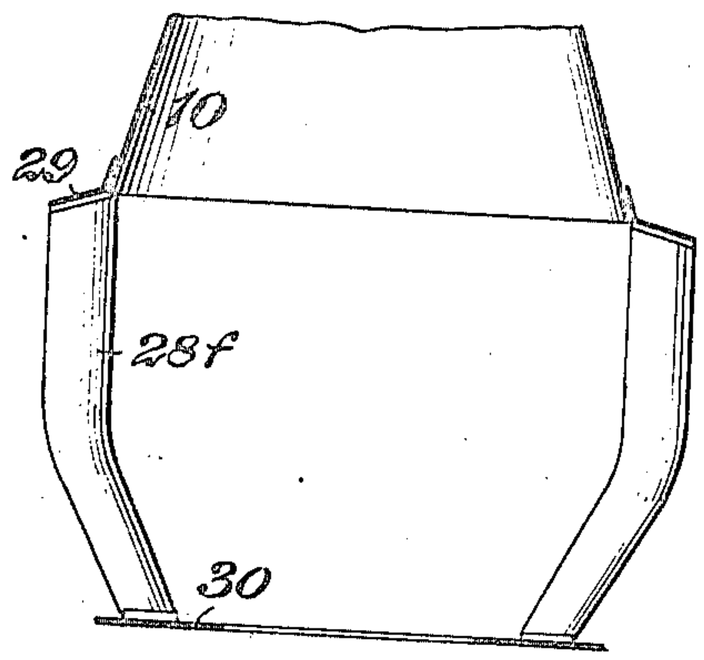


FIG. 9.

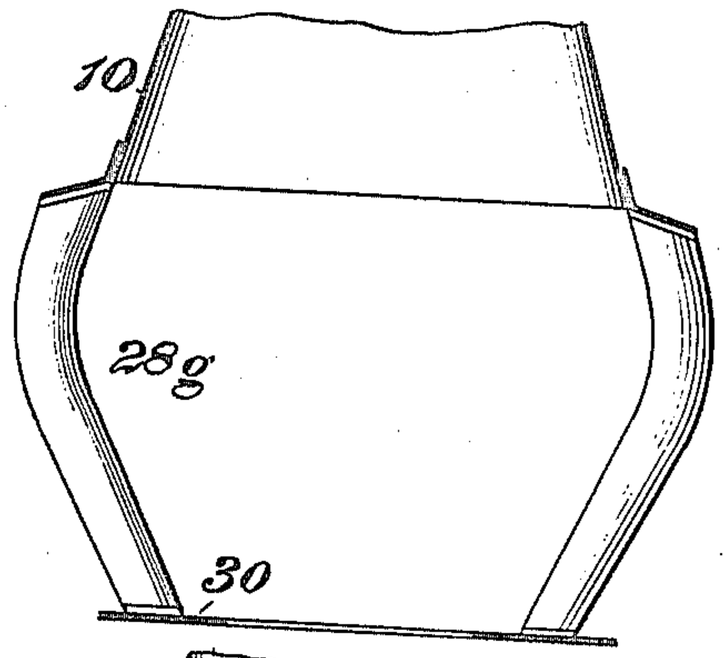


FIG. 7.

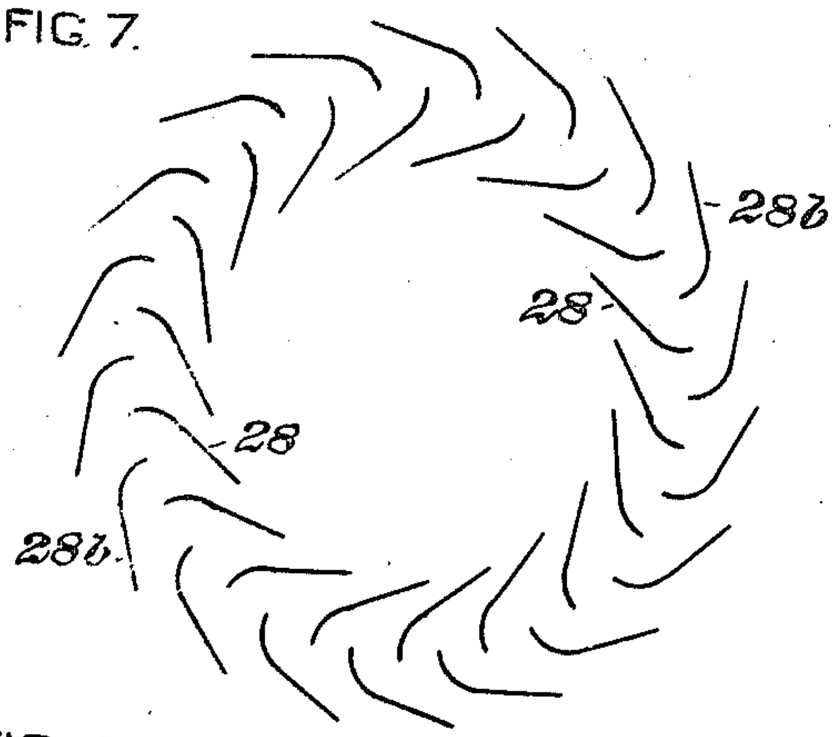


FIG. 7a.

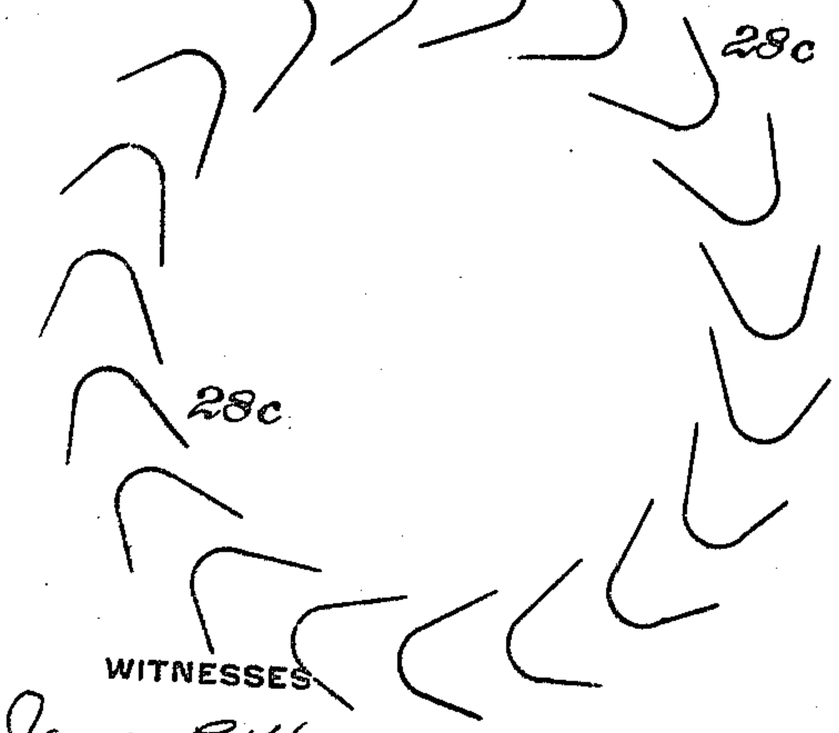
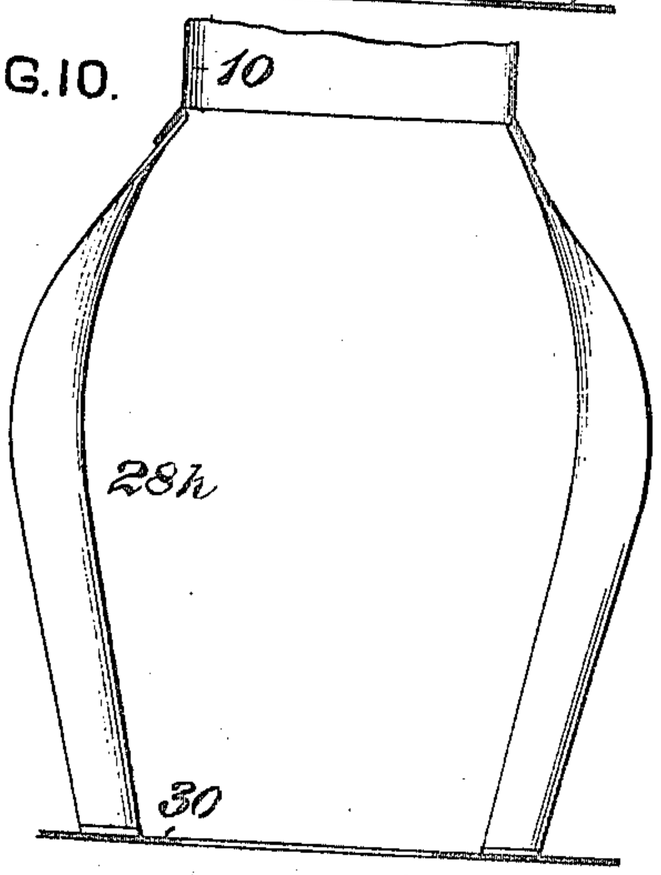


FIG. 10.



WITNESSES.

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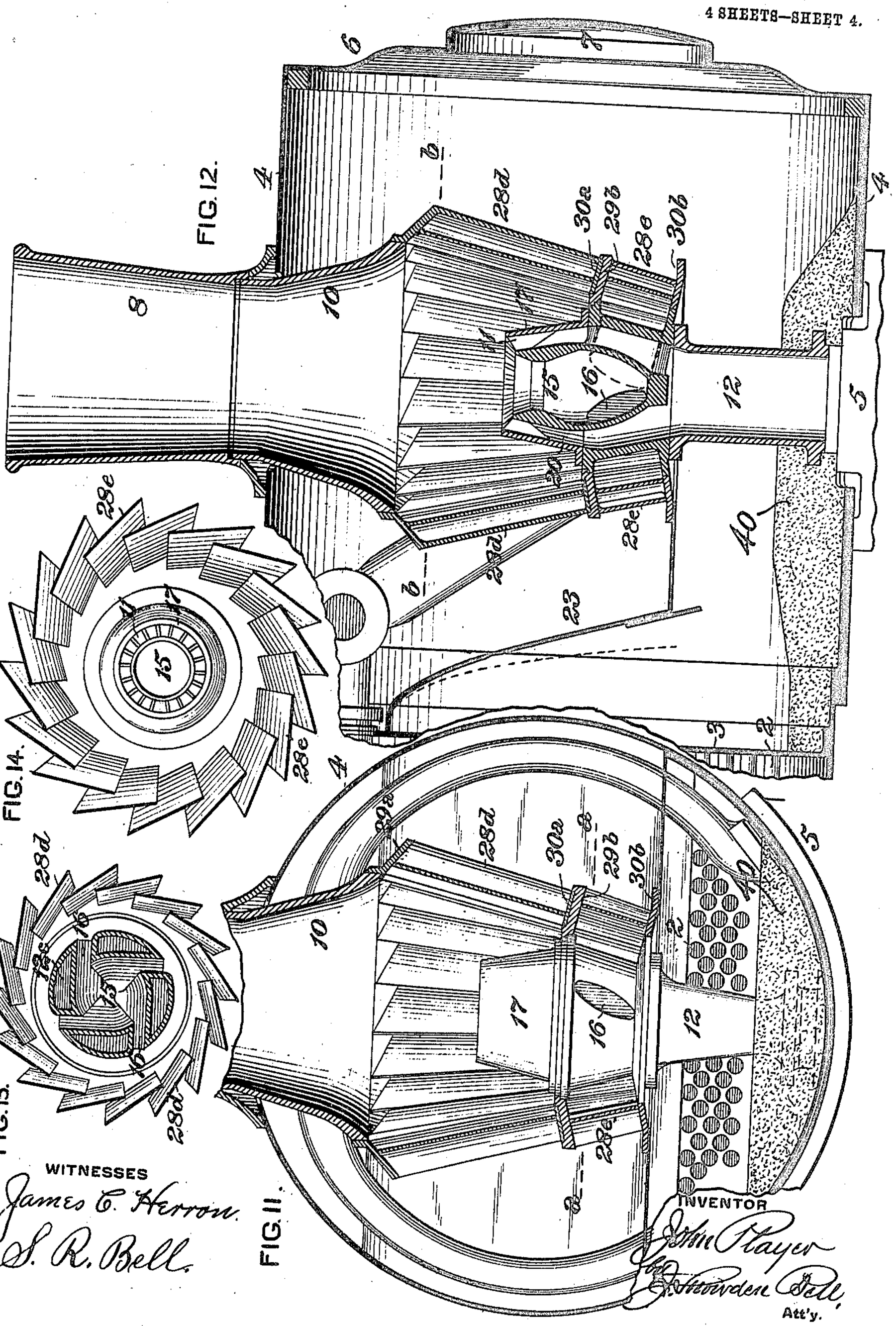
LOCOMOTIVE SPARK EXTINGUISHER.

APPLICATION FILED JUNE 2, 1909.

Patented Mar. 15, 1910.

4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

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LOCOMOTIVE SPARK-EXTINGUISHER.

951,994. Specification of Letters Patent. Patented Mar. 15, 1910.

Application filed June 2, 1909. Serial No. 499,667.

To all whom it may concern:

Be it known that I, JOHN PLAYER, of Schenectady, in the county of Schenectady and State of New York, have invented a certain new and useful Improvement in Locomotive Spark-Extinguishers, of which improvement the following is a specification.

The object of my invention is to provide a spark extinguisher for locomotive or other engines in which the draft upon the fire is created by a steam blast jet in the smoke stack, by the employment of which a gyrating motion will be imparted to the gaseous and solid products of combustion, prior to and during their traverse through an open smoke stack, and in which the solid products of combustion will, by the centrifugal force induced in their gyration, be thrown outward toward the wall of the smoke stack, and spirally rotated therein and entirely extinguished before they are ejected therefrom by the blast jet.

To this end, my invention, generally stated, consists of a spark separator for gyrating the products of combustion prior to and during their passage through the stack, and comprising a plurality of upwardly extending, circumferentially and angularly or turbinally disposed vanes, connected to the base of the smoke stack and the exhaust pipe, respectively. This apparatus I term a "gyrus" (from the Greek and Latin equivalents) and it will hereinafter be so designated.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings: Figure 1 is a vertical longitudinal central section through the smoke box, stack, and forward portion of the waist of a locomotive boiler, illustrating an application of my invention; Fig. 2, a vertical transverse section in the central plane of the exhaust pipe and stack; Fig. 3, a horizontal section, taken slightly below the base of the stack; Fig. 4, a vertical central section, on an enlarged scale, through the gyrus; Fig. 5, a plan view of the same, with portions of the upper and lower supporting rings broken away and a number of the vanes detached; Fig. 6, a horizontal section through a gyrus, showing the attachment of screens to the vanes; Figs. 7 and 7ª, diagrammatic horizontal sections showing the vanes of the gyrus as turbinally disposed; Figs. 8, 9, and 10, vertical central sections, showing variations of form, vertically, in the gyrus vanes; Fig. 11, a vertical transverse section through a locomotive smoke box and stack, taken in the central plane of the exhaust pipe and stack, showing a structural modification of my invention; Fig. 12, a vertical longitudinal central section through the same; Fig. 13, a horizontal section, on the line *a a* of Fig. 11; and, Fig. 14, a similar section, on the line *b b* of Fig. 12.

Locomotive spark arresters, as applied in practical railroad service prior to my invention, have generally consisted of a screen of netting or perforated plate, surrounding the exhaust pipe and extending therefrom to the smoke box, in such manner that no opening for the traverse of products of combustion was presented, around or through the spark arrester, of greater size than the meshes or openings in the screen. Other forms of spark arresters consisted of conical or cylindrical screens of netting or perforated plate, encircling the exhaust pipe and extending therefrom to the smoke stack. Combinations of these devices have also been experimented with, the essential feature of all of the above appliances being the interposition of a foraminous screen in the path of the products of combustion, between their exit from the boiler flues and their entrance into the stack, and combination with the blast jet. In still earlier designs, a screen of wire netting was placed at the top of the smoke stack, which was enlarged for its reception, the object being to interpose a screen in the path of the current of commingled exhaust steam and products of combustion, after its entrance into the stack and before its exit to the atmosphere. Additional means for deflecting and disintegrating the solid products of combustion, before passing through the screens, have also been applied. In many instances "bonnet" stacks have been used, these consisting of a cylindrical stack, provided, at its top, with a cone or deflector, against which the products of combustion were forcibly thrown by the velocity of the blast jet, and deflected into a conical receptacle, surrounding the cylindrical inside stack, from which they were ejected by the pressure of the blast between spiral vanes adapted to impart a rotation to them. In all appliances of this character, however, the rotation of the products of combustion was begun and accomplished after they had been commingled

with the jet of exhaust steam, and the period of rotation that was obtainable, was too short to extinguish the sparks, when the appliance was of such construction as to permit the use of exhaust nozzles of sufficiently large size. If the period of rotation was made sufficiently long to extinguish the sparks, the friction in the passages was increased to such an extent that it was necessary to so reduce the area of the nozzles, that the back pressure in the cylinders thereby occasioned, became so great as to impair the efficiency of the engine and render its economical operation impracticable. Moreover, it was not possible to maintain sufficient steam pressure in the boiler, owing to the great resistance of the spark arresting appliances, as it was not feasible to maintain a blast pressure which would both overcome this resistance and create a sufficient vacuum in the smoke box to support the rate of fuel combustion in the fire box necessary to generate the requisite amount of steam required in the service of the locomotive. Again, the different fuels used require different sizes of openings in the spark arrester screens. The area of each opening in the screens ordinarily applied with eastern bituminous coals is about .085 square inch; that for fuels used in the Middle West is about .05 square inch; that for the lignitic bituminous fuels of Montana, about .019 square inch; and that for the lignites of Wyoming about only .006 square inch, and, with some of them, about .003 square inch. Even with the finest of these openings in the spark arrester screens, with ordinary draft appliances when burning lignite fuels, showers of fine sparks are ejected from the stack.

Screens of fine mesh are subject to the objection of being frequently clogged with cinders, and, in the case of lignite fuels, when moisture comes in contact with the screen, as is occasioned by leakage or slopping over from the exhaust nozzle, the screen becomes coated over with a caked deposit, thereby choking the draft and causing the engine to fail for steam. Moreover, these fine mesh screens are very costly in maintenance, as by reason of their fine texture, they wear out rapidly, especially at points where the draft is more intense, thereby necessitating careful and minute inspection daily, and requiring frequent renewal, the life of such screens in average ordinary service not being above about three months.

It has been found in actual practice, that the fine sparks or "floaters" that are given off by lignite fuels, which will pass through the finest mesh screens that can be used, and are ejected, in great quantity, from the stack, and which it has heretofore been impossible to sufficiently and satisfactorily control by spark arresting appliances in the smoke box or stack, are entirely extinguished in the use of my improvement.

On railroads where different classes of fuel, which require different sized meshes in the spark arresting screens, are used, it frequently becomes necessary, by reason of labor and other difficulties, to change from one class of fuel to another. It is a well known fact that it is impracticable to burn bituminous coal in a locomotive equipped for lignite fuel, and vice versa, and hence, with changes of fuel, it is necessary to change the spark arresters, which involves considerable delay and expense. It is also often necessary at railroad division points, where lignite is used on one division and bituminous coal on the other, to change engines from one division to the other, as may be required by traffic conditions, thus requiring the change of spark arresters to be made to enable the engines to properly burn the class of fuel obtainable on the division on which they are to be run.

With my improvement applied, no change in the spark arrester is necessary when changing from one class of fuel to another, and consequently time and expense is saved, and the number of engines required at division points where different classes of fuel are used, is reduced.

Referring to the drawings, my invention is herein exemplified as applied in connection with a locomotive boiler of the type now standard on railroads, and with an exhaust pipe and exhaust nozzle of the types set forth in Letters Patent of the United Sates No. 673,726, granted and issued to the Brooks Locomotive Works, as my assignee, under date of May 7, 1901, and in pending applications for Letters Patent filed by me June 17, 1908, Ser. No. 438,912 and February 9, 1909, Ser. No. 476,922. The shell or waist, 1, of the boiler, is provided with a plurality of fire tubes, 2, extending from the fire box, which is not shown, to the front tube sheet, 3, through which tubes, the products of combustion pass from the firebox to the smoke box, 4, which is secured, at its rear end, to the front ring of the shell, 1, and, at its bottom, to the cylinder saddles, 5. The forward end of the smoke box is closed by a metal front, 6, having a central door, 7, and it is provided, at its top, with a stack, 8, having a downward extension or "penetration," 10, with a flaring or conical lower end, of comparatively large diameter, within the smoke box. A flattened floor of refractory material, 4°, which, however, does not form any part of my present invention, may be placed in the smoke box, if desired.

The exhaust pipe, 12, and annular exhaust nozzle, 17, herein illustrated, accord, in all substantial particulars, with those set forth in my pending application Ser. No. 476,922 aforesaid. The exhaust pipe is pro-

vided with exhaust steam passages, 12ᶜ, leading into an annular passage, 20, in the nozzle, from which the exhaust steam is discharged through a plurality of passages, 11, and a portion of the gases of combustion is drawn, by the vacuum produced by the exhaust jet, through entrainment passages, 16, in the exhaust pipe, and discharged therefrom through a central gas discharge passage, 15. My present invention is not, however, limited in application to combination with this or any other specific construction of exhaust pipe and nozzle.

In the practice of my invention, I provide an appliance for imparting a gyrating movement to the products of combustion which are discharged from the front ends of the tubes, 2, into the smoke box, prior to and during their passage through the stack to the atmosphere. This appliance, which, as before stated, I term a "gyrus", comprises a plurality of vanes or blades, 28, which extend from the bottom of the lower extension, 10, of the stack, to a plane some distance below the top of the exhaust pipe, 12, and are disposed circumferentially and angularly or tangentially, that is to say, with their general lines of direction at angles to radii of circles concentric with the exhaust pipe and stack, and means for supporting said vanes or blades in operative position. Said means are, preferably, as in the instance shown, an upper supporting ring or frame, 29, to which the upper ends of the vanes, 28, are secured, and which is fitted to the extension, 10, of the stack, and a lower supporting ring, 30, to which the lower ends of the vanes are secured, and which rests on an annular plate or flange, 12ᵃ, on the exhaust pipe, 12. The upper supporting ring may be either attached to the stack extension, 10, or fitted closely thereto without attachment, and the upper and lower supporting rings may either be made each in a single piece, with the vanes detachably secured thereto, or divided into two or more sections, each carrying a certain number of vanes, and themselves made detachable, so as to be readily removable for access to the exhaust nozzle.

In the structural modification shown in Figs. 11 to 14, the gyrus is divided into two sections, upper and lower, either by constructing the gyrus in two separate parts, the upper gyrus having a plurality of vanes, 28ᵈ, with upper and lower supporting rings, 29ᵃ and 30ᵃ, respectively, and the lower gyrus having a plurality of vanes, 28ᵉ, with upper and lower rings, 29ᵇ and 30ᵇ, respectively, or the gyrus vanes may be continuous and a dividing plate 30ᶜ, as shown in Fig. 2, inserted to separate the interior of the gyrus into two sections, the upper portion forming communication, through its vanes, between the smoke box and the smoke stack extension, while the lower portion forms communication, through its vanes, between the smoke box and the gas discharge passage, 15, of the exhaust pipe, through its entrainment passages, 16.

The elements of the gyrus may be made of sheet steel, riveted or bolted together, or of cast iron, divided into a suitable number of sections, each containing one or more vanes, and provided with a segment of a supporting ring or flange at its top and bottom, adapted to ready connection and disconnection to and from the stack extension and exhaust pipe, as by bolts and nuts. The stack extension is made of large diameter, so as to provide ample area for the gyration of the products of combustion exterior to the column of exhaust steam, prior to their entrainment thereby into the stack, and the stack is preferably made of the increased diameter which is permissible with the type of exhaust pipe and nozzle shown, so as to increase both the circumference and area. Such increase of diameter of the stack provides a greater length of circumferential travel for the gyrating solid products of combustion, and the increased area softens the draft through the stack and reduces the spiral pitch described by the solid products of combustion, which, in combination with the increased circumferential travel, materially prolongs the period of their passage through the stack.

The gyrus, as shown and as above described, is applied instead of the usual spark arrester netting or screen, and, under ordinary conditions, satisfactorily operates without the addition of such screen. Conditions may, however, arise under which the gyrus may be advantageously used in connection with an ordinary spark arrester, to perfect the operation thereof, or a screen of foraminous material of any suitable known design may be interposed in the path of the products of combustion before they enter the gyrus, as by providing front and rear sheets of wire netting or perforated plate, 25, and side sheets, 27, extending from the exhaust pipe to the diaphragm or deflecting plate, 23, and to the front and sides of the smoke box, as indicated in dotted lines in Figs. 1 and 2. To the same end, the vanes, 28, of the gyrus may be supplemented by foraminous screens, 28ᵃ, as indicated in dotted lines in Fig. 6, which are set at such an angle that the larger particles of the solid products of combustion will, during their rotation exterior to the gyrus, strike against said screens, and be disintegrated and deflected therefrom, while the gaseous products and finer particles will be entrained through the screens and between the vanes. The screens, 28ᵃ, are preferably set at such distance from the vanes as to provide openings between themselves and the vanes equal

to the openings between the vanes, so as to provide ample area if the screens should become clogged with cinders.

As shown in Fig. 7, there may be substituted for the screens, solid deflecting plates, 28^b, which will effect a reversal of the current of products of combustion exterior to the gyrus, and, as shown in Fig. 7^a, said deflecting plates may be made integral with the vanes, so as to provide vanes, 28^c, in the form of the buckets of a turbine. Both the vanes and the deflecting plates, when the two are separate, may be of turbine bucket form, as shown in Fig. 7, and the vanes and deflecting plates may be either both attached to the same supporting rings or frames, or the deflecting plates be attached to separate supporting rings, and made adjustable as to the relative openings between themselves and the vanes.

Figs. 8, 9, and 10 show structural modifications in the shape of gyrus vanes, 28^f, 28^g, and 28^h, to meet varying conditions in design of smoke boxes to which this apparatus may be applied, the vanes, 28^f, and 28^g, being enlarged in diametrical pitch to provide sufficient area therethrough where it becomes necessary to reduce the height of the gyrus and the vanes, 28^h, being constructed with diminishing openings toward the top, so as to admit a gradually lessened amount of the gases from the smoke box prior to entrance into the stack extension, 10. There is usually sufficient distance, in modern locomotive smoke boxes, from the center line of the exhaust pipe and stack to the deflecting plate, 23, to afford proper clearance, between the rear of the gyrus and the deflecting plate, to admit of the circulation or rotation of the products of combustion exterior to the gyrus. When, however, this is not the case, as in some locomotives of the older type, the center line of the smoke stack, exhaust pipe, and gyrus should be moved forward sufficiently far to provide the necessary clearance. This may be done by providing an exhaust pipe having its upper portion projecting forwardly from its base, so that the axis of its discharge opening or nozzle may coincide with the required vertical axis of the stack and gyrus, or the base of the exhaust pipe may be made at an angle to its body, so that its axis of discharge will be forwardly inclined, and the stack and gyrus be set so that their common axis will coincide with the inclined axis of the exhaust pipe. Sufficient room will thereby be provided for the proper application of the gyrus, and while this inclined position of the parts may be somewhat peculiar in appearance, it has not been found, in practical service, to involve any disadvantageous or objectionable result, and affords an inexpensive and effective means for the application of my invention in some of the existing constructions of locomotives of comparatively early design.

The function of the gyrus is, first, through the vacuum induced by the exhaust blast jet, to impart a rotating motion to the products of combustion exterior thereto; secondly, to cause their entrainment between the vanes of the gyrus; and, thirdly, to cause their gyration within the gyrus vanes, and, through the centrifugal force thus imparted to them, to separate the solid from the gaseous products, the lighter gaseous products being drawn by the vacuum induced by the blast jet, into the exhaust steam column or blast jet, and the heavier solid products being thrown outward by their centrifugal force and rotated or gyrated in close proximity to the vanes of the gyrus, in a gradually ascending spiral, but being prevented from striking the vanes by the gaseous cushion formed by continuous entrainment between the vanes. The gyrating column of products of combustion is held in rotating suspension and balanced, by the difference in intensity of vacuum created in the interior of the gyrus and in the smoke box exterior thereto, respectively. The gyration of the solid products of combustion, *i. e.*, sparks and cinders, continues in a spiral of gradually increasing pitch, within the conical lower extension of the stack, and when they come within the zone in which the exhaust steam column impinges upon the wall of the stack, they are commingled with said column, and finally ejected therewith from the stack. Owing to the rapid rotation or gyration of the solid products of combustion, prior to their contact with the exhaust steam column, and particularly when the exhaust pipe and nozzle of my pending applications before referred to are used in combination with the gyrus (said nozzles themselves imparting a rotating or gyrating motion to the blast jet) the products of combustion continue to rotate or gyrate in a spiral of greater increase of pitch, and are ejected from the stack in a spiral or gyrating column. The length and period of travel of the solid products or sparks are increased to such extent, and the sparks by contact, in their gyration, with the wall of the stack, are so retarded and disintegrated that they are thoroughly extinguished before being discharged from the stack.

In a "single" gyrus constructed with the interior continuous, the products of combustion passing therethrough are separated into two currents, the upper of which is induced by the vacuum caused by the exterior of the annular blast jet acting in the smoke stack, while the lower one is induced by the vacuum created by the interior of the annular blast jet acting upon the central gas passage of the exhaust pipe and causing a flow of gases

through the entrainment passages of the exhaust pipe. The difference in intensity of the vacuum so created varies considerably with the force of the blast jet emanating from the annular exhaust nozzle, and also differs in intensity with nozzles of different forms, so that, under different conditions of operation, the zones of entrance of the products of combustion through the vanes of the gyrus covered by these two currents varies, and while, in the majority of cases, this has no deleterious effect upon the successful operation of the device, it has been found, with some classes of fuel under certain conditions of operation, that it is advisable to divide the interior of the gyrus into two separate sections vertically, the upper section communicating with the exterior of the annular exhaust column, and the lower section with its interior, so that the zones of action may be clearly defined and preordinated. This may be accomplished by inserting a dividing or separator plate, 30ᵉ, within the gyrus so as to define the zone of entrance of the two currents, as before described, or by constructing a double gyrus having upper and lower sections, forming separate communication for the two currents induced by the exterior and interior of the annular exhaust jet, respectively, as shown in Figs. 11 to 14 inclusive.

Variations in form, number, angle and position of the various members of the gyrus and its location with reference to the smoke box, stack, and exhaust pipe, and in their axial angles, also variations in the form of the exhaust pipes and nozzles, may be made without departure from the spirit or operative principle of my invention. I do not therefore consider it confined or limited to the specific construction shown and described herein. My invention is equally applicable to boilers other than locomotives, using a blast jet for creating draft upon the fire.

I claim as my invention and desire to secure by Letters Patent.

1. The combination, with a locomotive smoke box, of an exhaust pipe and nozzle, a stack, and a separator for imparting gyration to the products of combustion, consisting of a plurality of vanes or blades surrounding the exhaust nozzle and disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, as herein specified as a "gyrus", interposed between, and connected to, the exhaust pipe and stack, respectively.

2. The combination, with a locomotive smoke box, of an exhaust pipe, a stack, and a plurality of vanes surrounding and disposed approximately tangential to circles concentric with, the exhaust pipe, and forming a "gyrus" as herein set forth, interposed in the path of the products of combustion and connected to said exhaust pipe and stack respectively, and through which the products of combustion are entrained and caused to gyrate by the action of the blast jet.

3. The combination, with a locomotive smoke box, of an exhaust pipe, a stack, and a "gyrus" consisting of a plurality of vanes or blades surrounding the exhaust nozzle and disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, said "gyrus" being interposed in the path of the products of combustion between said smoke box and stack and connected to said exhaust pipe and stack, respectively.

4. The combination, with a locomotive smoke stack, exhaust pipe, and nozzle, of a "gyrus" consisting of a plurality of vanes or blades surrounding the exhaust nozzle and disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, as herein set forth, said "gyrus" being connected to the exhaust pipe and stack and adapted to entrain and gyrate the products of combustion within said stack by the vacuum created by the exhaust jet.

5. The combination, with a locomotive smoke box, of a smoke stack, and an exhaust pipe having connected thereto a "gyrus" as herein set forth, composed of a plurality of vanes surrounding the exhaust pipe and disposed approximately tangential to circles concentric thereto, so as to impart a gyrating motion to the products of combustion after their entrainment between said vanes, by the vacuum caused by the exhaust jet.

6. The combination, with a locomotive smoke box, of a smoke stack, and an exhaust pipe connected to and surrounded by a separator or "gyrus" as herein set forth, comprising a plurality of vanes disposed approximately tangential to circles concentric with the exhaust pipe, so that the vacuum produced by the exhaust jet will entrain the products of combustion through openings between the vanes and impart a gyrating motion thereto, causing the separation, by centrifugal force, of the solid products of cinders and sparks from the gaseous products and a prolongation of travel of the solid products.

7. The combination, with a locomotive smoke stack and exhaust pipe, of a separator or "gyrus" surrounding said exhaust pipe, consisting of a plurality of vanes or blades disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, as herein set forth, and connected to the smoke stack and exhaust pipe, for imparting a gyrating motion to the gaseous and solid

products of combustion and separating and prolonging the travel of the solid products by centrifugal force, after passing therethrough, by the vacuum caused by the exhaust jet.

8. A separator or "gyrus", as herein set forth, for locomotive smoke boxes, comprising a plurality of upwardly extending tangentially disposed vanes, surrounding the exhaust nozzle, into which the products of combustion are entrained and gyrated therein by the vacuum caused by the exhaust jet.

9. The combination, with a locomotive smoke box, of a smoke stack, an annular exhaust pipe provided with passages for the entrainment of a portion of the products of combustion, a lower "gyrus" consisting of a plurality of vanes or blades disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, as herein set forth, said lower "gyrus" surrounding said entrainment passages and being connected to said exhaust pipe, and an upper "gyrus" consisting of a plurality of similarly disposed vanes or blades, surrounding the annular discharge of the exhaust pipe, and connected to the stack and exhaust pipe, respectively.

10. The combination, with a locomotive smoke box, of a smoke stack, an annular exhaust pipe provided with passages for the entrainment and discharge of a portion of the products of combustion, a "gyrus" consisting of a plurality of vanes or blades disposed with their general lines of direction approximately tangential to circles concentric with the exhaust pipe and stack, as herein set forth, said gyrus being connected to the exhaust pipe and stack respectively, and a partition or separator plate disposed within said "gyrus" for dividing it into upper and lower sections and separating the currents of the products of combustion induced by, and diverting one portion to the exterior and the other to the interior of, the annular exhaust jet within said stack.

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Witnesses:
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