

July 28, 1925.

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M. PENN

TUBE CLEANING SYSTEM

Filed March 28, 1921

Fig. 1.

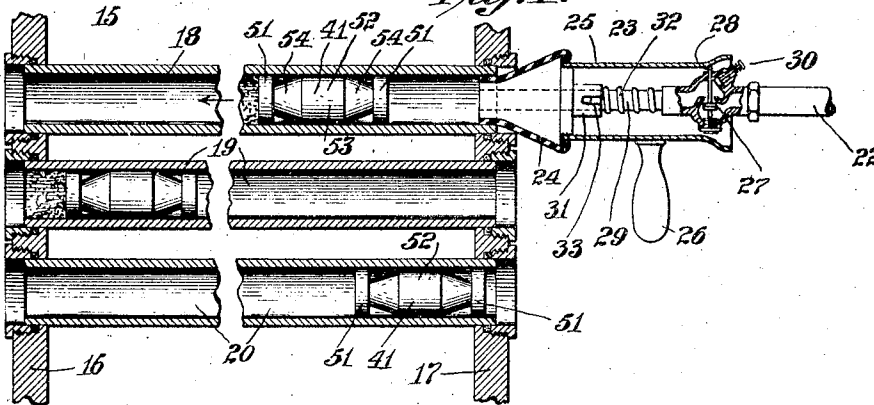


Fig. 2.

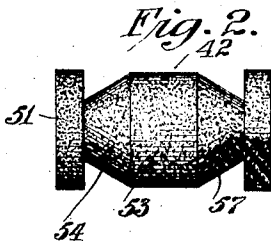


Fig. 3.

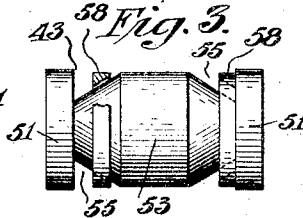


Fig. 4.

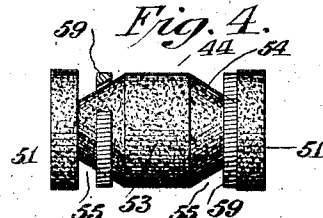


Fig. 5.

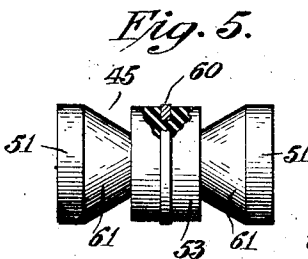


Fig. 6.

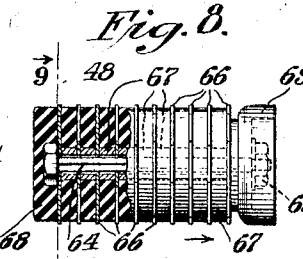


Fig. 7.

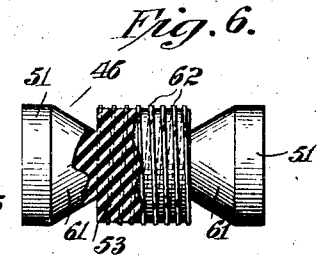


Fig. 8.

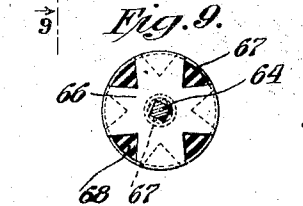
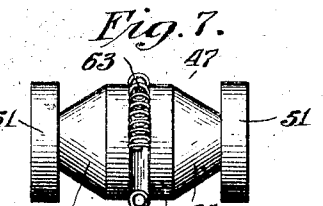


Fig. 9.



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TUBE-CLEANING SYSTEM.

Application filed March 28, 1921. Serial No. 456,445.

To all whom it may concern:

Be it known that I, MARION PENN, a citizen of the United States, residing at Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Tube-Cleaning Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention is a novel tube cleaning system, and has especial reference to means for cleaning the tubes of condensers, within which forms an accumulation of slime, mud and loose dirt to the material detriment of the efficiency of the condenser. It is well known that the accumulations within the tubes of a condenser are the cause of a gradually increasing inefficiency until, at the last, a very enormous loss sometimes occurs. The objection is so pronounced that many schemes have been attempted for eliminating the accumulation of dirt in condenser tubes. So far as I know none of these schemes has been widely adopted excepting that involving the use of a metal brush inserted and forced through the tubes of the condenser; these, however, involving high expense in material and labor, the brushes moreover rapidly deteriorating, and causing steady wear upon the condenser tubes. One of the main objects of the present invention is to afford a system of cleaning tubes which will avoid the objections mentioned, and I have devised a system and means for this purpose, as will be hereinafter more fully described, which is cheap in cost, inexpensive in operation, simple, effective, durable, and non-injurious to the tubes. Another object of the present invention is to provide a system by which a condenser having a large number of tubes may be cleaned in a very short space of time, rendering it available where in many circumstances it would not be permissible to stop the operation of the condenser long enough to permit cleaning. While I have particularly referred to the cleaning of condenser tubes my invention could obviously be used for cleaning analogous tubes, such as boiler tubes, in which a coating of loose dirt, slime and the like is liable to form.

The plug of this invention can be satisfactorily used in a condenser wherein there are slight variations in tube diameter, which

frequently occurs in practise, the characteristics of my plug being such that it adjusts itself without impairing its efficiency.

To the attainment of the above recited objects and advantages, the present invention consists in the novel system or means of cleaning tubes, also the novel tube cleaning plug, and the apparatus for driving the plug through the tubes, and the other novel features of combination, arrangement, construction or detail herein described or illustrated.

The general plan of the present invention is to employ an effective plug or cleaner which can be inserted within the bore of each tube, together with an apparatus for delivering a charge of compressed air or steam, or sometimes water, behind the plug to force or drive it like a projectile through the tube, the plug carrying the mud, slime and dirt ahead of it and discharging the same at the opposite end of the tube. The invention also involves novel principles in the construction and composition of cleaning plugs, as well as several specific forms embodying the same, and a novel means for delivering the air for the propulsion of the plug.

In the accompanying drawings, Fig. 1 is a vertical section taken through a portion of a condenser showing the heads at the opposite ends thereof and a plurality of condenser tubes, to which is shown applied the present invention for the purpose of cleaning such tubes. In the lowest tube the plug has merely been inserted; in the uppermost tube air has been applied and is driving the plug and dirt toward the rear; in the middle tube the plug and dirt are about to pass out at the rear end of the tube.

Fig. 2 is a detached side elevation of one of the plugs or cleaners of the present invention, similar to that in Fig. 1 but composed of a different material.

Fig. 3 and 4 show modifications of structure in which the form of plug of Figs. 1 or 2 is supplemented by loose metallic rings or scrapers.

Figs. 5, 6 and 7 show other forms embodying metallic portions.

Fig. 8 shows a still different form, and Fig. 9 is a cross section taken on the line 9-9 of Fig. 8.

The condenser 15 is herein represented merely by showing portions of the heads 16 and 17, to which the opposite ends of the condenser tubes 18, 19 and 20 are fitted in a usual manner.

The means or appliance for forcing the plugs through the tubes is shown as comprising a compressed air pipe 22 extending to the mechanism or appliance 23, the pipe being flexible so that the appliance can be moved about by hand and inserted at will within the ends of the respective condenser tubes. The appliance 23 comprises a cone or tapered mouth 24 which can be fitted with comparative tightness in the end of the condenser tube, and a cylindrical casing 25 extending rearwardly from the mouth-piece. A handle 26 may be provided to facilitate the carrying and operating of the device.

Normally the supply of compressed air will be shut off by a valve 27, which, as shown, is preferably of a quick opening type, so that upon operation the full force and effect of air pressure and flow are delivered abruptly against the cleaner plug. The valve has a stem 28 extending outwardly and which has only to be depressed to open the valve and admit the air to the condenser tube. The flexible pipe 22 is connected to the rear end of the valve 27 and from the other end of the valve extends a pipe 29 which may be continued into the tapered mouth 24.

Under the impetus of the air pressure the plug starts forward and travels rapidly through the tube carrying the dirt before it, the air flowing as rapidly into the space behind the plug to maintain its travel. Occasionally a plug may become stuck within the tube for one reason or another and in such cases it is desirable to avoid the unimpeded delivery of compressed air behind the plug. For this purpose, and also to give warning to the operator of the stoppage of the plug, I have provided in the wall of the valve 27 a safety device or escape 30 controlled by a spring and acting to yield and deliver air into the atmosphere when the pressure within the appliance becomes excessive.

Instead of requiring the operator to open the air valve 27 by hand after inserting the appliance within each condenser tube I have provided an arrangement whereby this is performed automatically. For this purpose the casing 25 is formed with a flared rear end as shown, this acting as a cam, and serving to force inwardly the valve stem 28 when the valve is moved relatively forward. This action is permitted by the fact that the valve is not rigidly connected to the casing. The pipe extension 29 is arranged so that it may slide inwardly through the casing or head 31 of the casing. A spring 32 gives a constant tendency to throw the valve rearwardly and thus permit its closing. A pin

and slot device 33 between the pipe 29 and the head 31 limits the relative movement between the valve and the casing.

The operation of this part of the invention may be as follows. The operator, holding the apparatus by the handle 26 and the pipe 22, inserts the tapered mouth 24 within the condenser tube 18, forcing it home by the handle 26, and in the same movement continuing the forward thrust of the pipe 22 so as to cause the yield of the spring 32 and the automatic opening of the valve 27, giving an immediate and forcible blast of air which serves to drive the plug through the tube. The parts are shown in this position in fig. 1. As soon as the plug has passed through the tube the operator draws back on the members 22 and 26 thus closing the valve and removing the appliance.

The plug may take various forms, such as shown at 41 Fig. 1, 42 Fig. 2, 43 Fig. 3, etc. In the illustrative form shown in Fig. 1, the plug 41 is shown as comprising two separated flange portions 51, 51 composed of tough resilient rubber of good quality, these piston like flanges, especially the front one, being of sufficiently large diameter to give a tight fit with the tube, and of such longitudinal dimension or thickness that the flange will act, not as a mere washer, but by circumferential compression, thus giving an expanding forcible pressure against the inner walls of the tube to be cleaned. For example, if the tube interior diameter be $7/8$ inch the diameter of the flange portion 51 will be a full $7/8$ inch or slightly thereover so that a certain compression exists in the flange, giving the intimate contact necessary for a thorough cleansing operation. The thickness of the flange, for example may be $3/16$ inch. Between the separated flanges, 51, 51 is shown an elongated body portion 52. With the assumed dimensions of the flange, the total length of the plug may, for example be 1 and $11/16$ inch. I prefer that the middle portion 53 of the body of the plug shall be nearly of the diameter of the tube bore, for example $55/64$ inch, so as to give a loose fit as compared with the flanges, yet preventing displacement of the plug as a whole, and giving a certain additional cleaning action where the amount of dirt is such as to come into contact with this part of the plug. Between the plug portions 53 and the flanges 51 are portions 54 of reduced diameter giving recesses 55 between the respective flanges and the body portion, these recesses serving to receive, accumulate, and carry along a certain amount of dirt not forced ahead of the foremost flange. It will be noticed that the described shape of plug is such as to permit easy insertion and entrance into the end of the tube, the flanges yielding sufficiently to permit this to be done by hand and yet to give a tight fit, affording

great cleansing power when the plug is shot through the tube by the application of compressed air.

The described cleaning plug 41, as shown in Fig. 1 may consist simply of a single piece of elastic rubber molded into the form shown, with the several described portions of the plug integral with each other. Such a plug is simple in form, cheap of manufacture, and durable in use. Roughly, a single plug can be used for several hundred cleaning operations before it wears sufficiently to render it ineffective for the particular size of tube for which it was constructed. The plug is wholly harmless to the tube and gives high cleansing efficiency. The length of the plug, and its spaced apart flanges, also its central body portion nearly of the full diameter, all tend to keep the plug parallel, in its true path of motion, so that the tight fitting flanges with their substantial bearing surfaces and sharp edges will work to maximum efficiency.

While in some cases the spaced apart flanges will do the work without the large diameter body portion 53, the latter gives a better plug, and its efficiency is increased by reason of the tendency of the body to become distorted and expand, giving increased pressing contact against the tube when the air pressure squeezes the plug lengthwise, as observed by comparing the bottom plug in Fig. 1 with the other two. The flanges are preferred to be formed with square corners in cross section, as shown, giving a sort of cutting action upon the soft dirt, slime, etc.

In practice a large number of plugs will be kept at hand. Assuming a condenser having six thousand tubes it is preferable to employ, say fifteen hundred plugs, made to the proper size of the tubes, this large number of plugs saving labor. One workman may insert the plugs in the respective tubes while a second one follows with the appliance for admitting compressed air behind each plug. He passes rapidly along from tube to tube, each operation being almost instantaneous. The operation is wholly free from the unpleasantness from dirt and odor which pertained to the older systems and led to neglect in caring for the condensers. Where plugs have been heretofore attempted these have been inferior in results, defective in action, and damaging to the tubes. The present invention meets these difficulties. The composition of the plug of resilient rubber enables the air pressure to compress it slightly, tending to increase the closeness of the fit. The plugs inserted at the front emerge at the rear, driving the mud ahead of them as indicated in Fig. 1. It is preferred to install a perforated basket to catch the plugs, which can be returned in quantities to the front of

the condenser and applied, either to a different group of tubes, or with systematic repetition to the same tubes if it be desired to secure maximum results. I estimate that where, with the brushing system, the assumed condenser might require an expense of \$125.00 for a single cleaning, the present invention will save, in labor and material, 75% or more of this cost, and the great reduction in time consumed minimizes the disturbance in operation of the plant to which the condenser is attached.

The plug itself is well adapted to the purpose; it is practically indestructible in use and lasts indefinitely; it is unitary with no connected components to come apart; its flanges are integral and resilient and can yield or collapse to pass an obstruction, while affording elastic expansive pressure and contact against the tube; and it meets all the other objects and advantages stated at the outset.

The plug 42 shown in Fig. 2 is the same as the plug in Fig. 1, excepting that the material 57 of which the flanges and body are composed is a composition of rubber containing abrasive material, indicated by the dotted appearance on the drawing, such as fine particles of emery. This employment of abrasive rubber in the construction of the plug is of decided advantage in those cases where a scale or hard crust tends to form in the tubes. Without injuring the tubes, the abrasive surface of the rubber, in the repeated cleaning operations, tends to keep the tube free from all such scale or crust, and to afford the greatest degree of heat conduction in the cooling action of the condenser.

Such an abrasive plug may be produced by incorporating in the raw rubber before vulcanization a suitable quantity of powdered abrasive, such as emery, for example in the amount of 25% of the weight of the rubber. This will not interfere with the proper molding and vulcanization of the rubber in the production of the plugs. The emery and rubber should be thoroughly mixed before molding.

In the modified plug 43, shown in Fig. 3, the general characteristics may be the same as in Figs. 1 or 2, but Fig. 3 shows an additional feature in the form of a metallic ring 58, or two such rings, confined in the spaces 55. These rings are shown as constructed of metal and having sharp edges so as to further assist in the removal of crust or caked material. These rings are preferably of the loose fit diameter of the middle portion 53 of the plug.

In the modification, shown in Fig. 4, loose metallic rings 59 are likewise shown, in this case the rings having rough or toothed peripheries to further assist in the described scraping and meaning action.

Fig. 5 shows a further modification in which a metallic ring 60 is embedded in a groove in the rubber. In this case, the metallic ring is shown as having the full diameter of the tight fitting rubber flanges 51, thus giving a close fit. In some cases it might be desirable to employ such a plug immediately following a cleaning operation with a plug of the kind shown in Figs. 1 or 2. Fig. 5 also shows a somewhat different form of plug body. The rubber portions 61 between the flanges 51 and the body middle 53, being slanted reversely, as compared with Figs. 1 to 4.

In Fig. 6 a helical strip of metal or coil spring 62 is shown wound around the body portion of the plug, giving several spiral grooves and a more extended and efficient scraping action by the metal. A variation is shown in Fig. 7 in which a coil spring 63 is wound bodily around a groove formed in the plug body.

In some cases it may be desirable to embody the metal parts in connection with a core and Figs. 8 and 9 show such a form. An interior bolt 64 has a confining nut 65 and along its length are alternate disks 66 and washers 67, the disks being cut away as indicated. This structure or skeleton is inserted in the rubber mold and the rubber 68 is formed and vulcanized in the manner shown, with a head 69 of the full diameter of the condenser tube, the disks being shown of the same diameter.

It will be noted that each disclosed embodiment has one or more cleaning portions or heads, 51 or 69, at the ends. When turning these heads flanges it is intended to bring out that the thickness is not too great to permit the ready bending of the material as the flange yields in inserting it into the tubes, the diameter in that case being sufficiently great to give a tight fit and effective pressure against the tubes though the latter vary slightly in diameter, as they do in practise. The flanges may also yield during operation when the plug is being propelled by the fluid pressure, but their substantial thickness ensures continued cleaning pressure on the tube walls. In Figures 5 to 9 the middle portion of the plug may be said to be grooved.

It will thus be seen that I have described a tube cleaning system embodying the principles and attaining the advantages of the present invention, and as means for carrying out such system, a novel tube cleaning plug, also a novel apparatus for driving plugs through tubes, all in accordance with the principles of the present invention. While such principles have been illustrated by specific examples, nevertheless the same principles could be utilized with various modifications of construction, combination, arrangement, and other features, and it is not intended

to limit the invention to the particular features illustrated except in so far as set forth in the appended claims.

What is claimed is:

1. A tube cleaning plug having an elongated body and tight fitting heads composed of resilient rubber, and with a loose metallic element surrounding the body and confined by a head.
2. A tube cleaning plug having a middle portion slightly less in diameter than the bore of the tube, and spaced apart flanges of substantial thickness and the full diameter of the bore, all composed of a single integral piece of tough resilient rubber.
3. A tube cleaning plug comprising a body portion, a flange spaced therefrom and composed of rubber, and a circumferential metallic portion assembled therewith.
4. A plug according to claim 3 and wherein the metallic portion is a ring loosely engaged in the space adjacent the flange.
5. A plug according to claim 3 and wherein the metallic portion is exteriorly roughened for abrading purposes.
6. A fluid-propelled tube-cleaning plug composed entirely of tough resilient rubber and formed with an elongated body and cleaning heads at the ends, each of substantial thickness and substantially fitting the tubes to be cleaned, at least one of said heads being a flange of sufficient diameter to give a tight fit and pressure against tubes slightly varying in diameter.
7. Plug as in claim 6 and wherein the body comprises a cylindrical portion spaced from tight fitting end flanges at both ends, the body being slightly more loose fitting than the flanges, and adapted by its resilience to expand under the endwise compression and press against the tube wall.
8. A tube-cleaner consisting of an elastic projectile having end flanges, and an intermediate portion adapted to function with said end flanges said flanges adapted to collapse in opposite directions under air compression or pressure to provide clearance for the plug or cleaner in case of its passage being otherwise impeded through the condenser or other tube.
9. A tube-cleaner consisting of a projectile plug of elastic material having end-flange-forming annular portions and an intermediate cylindrical portion, said flange-forming portions being of somewhat greater diameter than the intermediate cylindrical portion.
10. A plug adapted to be forced by air pressure through condenser tubes or the like for removing slime and dirt, the same consisting of an integral piece of resilient rubber of elongated form and shaped with piston-like flanges including a front flange tightly fitting the tube to be cleaned, so that a cleaning contact is attained by the elastic

outward pressure of the flange after being entered into the tube, and a body of less diameter than the flange diameter and tube bore, so that the plug may operate effectively upon tubes having variations of bore; and a rear flange tightly fitting the tube whereby when the front flange meets excessive resistance in the tube the air pressure behind the plug effects distortion of the rubber to give expansion and increased cleaning pressure against the tube. 10

In testimony whereof, I have affixed my signature hereto.

MARION PENN.