FILTH THE CAUSE OF BOILER EXPLOSIONS.

The following interesting facts are taken from the report of Mr. A. T. Hay, to the Secretary of the Treasury of the United States, on the subject of boiler explosions

When we boil pure water the steam rises regularly in spheres from the bottom of the vessel to the surface of the water. The volume of a confined mass of steam is inversely proportional to the pressure to which it is exposed, and directly proportionate to its absolute temperature Steam at a like temperature and pressure has at all times the same number of molecules in a like volume, and the true measure of its energy may be calculated with mathematical precision Water assumes three natural, or allotropic forms—liquid, solid, and vapour, in all these forms its qualities inhere What is true of a molecule of water, ice, or steam, is true of the whole volume of either—these several forms being due entirely to a change of temperature. Water is the most stable compound in nature; neither pressure, cold, nor heat alone being able to reduce it to its original elements. It also has a greater capacity for heat than any other known substance, except hydrogen gas. Water, *per se*, is as true to its peculiar characteristics under the various degrees of temperature and pressures to which it may be subjected, as the magnet is to the Polar star.

Steam is an elastic fluid, and has the true measure of its energy in any given case directly proportional to its temperature and pressure. These two conditions supplement each other. Now, the volume of a confined mass of steam being inverse to the pressure to which it is exposed, a rupture in a steam boiler must instantly reduce the internal pressure and relieve the stress, and, on the other hand, the pressure being directly proportioned to the absolute temperature, the checking in of cold water reduces the temperature and relieves the pressure or tension; which brings us to the logical conclusion that neither a weak place in a boiler nor the supplying of cold water are, in themselves, the least sources of explosion "But, we are told, "it is the discharging of cold water on to red-hot iron that does the mischief." Let us look at that in the light of truth. In the first place, water has nearly ten times the capacity and affinity for heat that iron has, and I will defy any man to heat any part of a boiler or open kettle red-hot with an ordinary blast so long as there is any considerable quantity of water therein; beside, if it were possible to have any portion of a boiler "red hot," it would be above the water line — whereas, the cold water (on river steamers) is supplied either through the mud drum or discharged by feed pipe near the bottom of the boiler Now, it is a fact that boilers blowing up under such supposed conditions generally go at the first or second stroke of the pump. Then, I would ask, how high a few strokes of the pump will raise the hot water over a battery of boilers? Not the thickness of a sheet of brown paper Another fact is that many of our most terrific explosions take place under a reduction of pressure—that is, the boilers become, as it is termed, "fire hard," and sometimes it is with difficulty that a medium gauge of steam is kept up; in fact, I have known instances wherein just before an explosion ensued the steam gauge would recede from 50 lb. to 20 lb. pressure, and no amount of firing would bring up the pressure sufficient to perform the work satisfactorily. If there had been a scarcity of water there would have been a surplus of steam. When boilers fire easily and steam freely there is no danger of any fearful disaster. If a boiler gives way under such conditions, it is at its weakest point, which lets off the excessive pressure and relieves the stress instantly over the whole battery. Such accidents are of frequent occurrence. They are simply ruptures, the effects of over-pressure, and not explosions in any sense of the term.

There can be no violent explosion from steam made from clean water, free from organic matter. At least, after many years' close observation, coupled with direct investigation and research, I have failed to find an instance where pure simple steam made from clean water ever exploded within a range of from 15 lb. up to 500 lb pressure to the square inch. But I do find that explosions in steam boilers (like cholera, typhoid fever, &c.) revel in filth and foul water, and may be traced directly to the same source. Take, for instance, the Mississippi and its tributaries, and it will be found that steamboat boiler explosions have been most frequent in the vicinity of large cities, and as we go down the river. The Lower Mississippi has been termed a graveyard, while in that portion of the river above St. Louis, including the Illinois, where the waters are comparatively pure and free from nitrogenous matter, explosions have been very rare, while the Ohio, from Cincinnati down, is noted for many steamboat disasters The most destructive and terrific explosions have occurred in the spring of the year, when the waters were loaded with organic substances, earthy salts and oleaginous matters.

My researches lead me to a positive conviction that these disasters have their origin in the impurities contained in the water In a paper like this it is impossible to go into detail, or to give reasons and incidents running through many years observations investigation and research, but I think that the following will give a sufficient data to enable all to see the importance of avoiding foul water for steam purposes.—

When we boil foul water we find it tumultuous, accompanied with a low, thumping sound, with fits and starts, so sudden and violent in some instances as to jump bodily out of or even burst an open vessel. This antagonism to the boiling of any compound solution is caused by the attraction of these foreign particles for each other (chemical action and reaction), while in the boiling of pure water there is no chemical action whatever. Great rivers, like those in the Ohio, Mississippi, and Missouri valleys, are great natural sewers, and their waters at certain seasons of the year are loaded with organic remains in every stage of putrefaction, while city wells and those around factories frequently become great sink-holes and receptacles for foreign matter My researches show that such waters hold in solution and carry in suspension from six up to sixty-three grains per gallon of organic substances, to which may be added copious quantities of oleaginous matter in certain localities and the salts of ammonia—NH_3. These substances find their way into steam boilers, where they rapidly undergo chemical change, distillation, concentration, and sometimes violent decomposition—that is, culminate in terrific explosion

These organic skeletons, glycerine salts, albuminous substances and ammoniacal gases found in water consists chiefly of carbon, hydrogen, oxygen and nitrogen, and it is among such nitrogenous combinations and types that we find some of the most remarkable explosive bodies. They are not only aeriform, but they are gases of the most subtle and potent character; gelatinous substances, in which the different elementary atoms are all chemically combined in the same molecule that are liable to sudden and violent decomposition whenever the opposing forces to which they owe their existence become deranged by heat or some external cause. Their affinities are very feeble hence their frequent destruction at high temperature Merely a molecular disturbance of any kind may cause violence Their combustion being internal and instantaneous, they develop a force at least ten times greater and 100 times quicker than that of steam pressure—sudden and violent enough to destroy open vessels.

The instability of all nitrogenous compounds is the striking peculiarity. No amount of pressure or cold is able to reduce their aeriform gases to the liquid or solid condition again. But in clean water we have the most stable substance known, under these distinct forms, either of which may be safely had out of the other by merely a change of temperature. As I said before, heat alone will not decompose water, but electricity readily resolves it into its original elements, and chemical action being the source of electricity, water in the midst of fickle and treacherous company becomes demoralized and loses its virtue and stability, and goes off in a gaseous state in time of chemical reaction This frequently occurs when boilers explode, as neither water nor steam are ejected from them, but an inflammable gas is evolved Under such conditions the engineer, dead or alive, is convicted of murder for allowing the boilers to become dry, when, in reality, a moment before the explosion his boilers contained a full gauge of water

Great power in the hands of ignorant managers implies great dangers, which has been practically illustrated in American steamboating, railroading, &c Science take things as it finds them, and occupies itself in tracing relations and dependencies among phenomenal effects Any investigation, to have any permanent value, must be based upon the natural order of things. It must be interwoven with matter, force, and truth. Then intelligence becomes a true mirror that reflects things as they are. It is only by well observed and well digested facts, through patient investigation and research along the varied lines of nature that we generate new and recast old ideas and arrive at truth and practical utility.