

**CITY OF MILWAUKEE v. ACTIVATED SLUDGE, Inc.**

**No. 5001**

**Circuit Court of Appeals, Seventh Circuit**

**69 F.2d 577; 1934 U.S. App. LEXIS 3600**

**March 2, 1934**

[\*578] Before EVANS, SPARKS, and FITZHENRY, Circuit Judges.

SPARKS, Circuit Judge.

This is an appeal from a decree of the District Court holding the following United States patents issued to Walter Jones valid, and that appellant has infringed the following enumerated claims:

Claims 2, 3, 7, 11, and 13 of No. 1,247,540 issued November 20, 1917, on application filed October 9, 1914.<sup>1</sup>

<sup>1</sup> No. 1,247,540.

"2. The process of treating sewage and the like, consisting in causing a local upflow in the liquid, supplying air into the liquid in its upflow, and causing this liquid and the sludge or solid matters contained in it to flow to a point of the part of the flow which is being supplied with air.

"3. The process of treating sewage and the like, consisting in causing a local upflow in the liquid, and supplying air locally into the liquid in its flow, causing the sludge or solid matters to pass to a point of the part of the flow which is being supplied with air, and removing the clarified liquid from the body."

"7. The process of treating sewage and the like, consisting in causing an up and down flow, and a lateral flow in the liquid, and returning the sludge to the upflow."

"11. The process of treating sewage and the like, which consists in introducing air locally into the mass of liquid at a plurality of points, and thereby setting up upcurrents in the sewage over the air supply localities, and permitting the sewage to flow

outward from the upper part of one of the upcurrents, and descend and flow into the path of another upcurrent."

"13. The process of treating sewage and the like, consisting in delivering locally to the lower portion of a mass of sewage a plurality of successive increments of infusions of minute bubbles of air; causing the sewage at the points of delivery of increments of air to rise by the infusion of air therewith; and causing the sewage freed of the air to fall and come under the influence of succeeding increments of air."

[\*\*2] [\*579] Claims 2 and 8 of No. 1,282,587 issued October 22, 1918, on application filed November 7, 1916 (a division of the application resulting in United States patent No. 1,247,540).<sup>2</sup>

2 No. 1,282,587.

"2. In an apparatus for purifying sewage, comprising a tank, means for introducing air or oxygen at the lower part of the tank, said tank being of a size above the air-introducing means to provide a material-receiving area above and laterally of such means and beyond the direct influence of the air from such means, the tank being inclined adjacent and laterally of the air introducing means to induce a flow of material to such means from that portion of the tank beyond the influence of such means."

"8. In apparatus for purifying sewage, a chamber; a plurality of air supply devices in the bottom of the chamber separated a substantial distance from one another, a surface between said air supply devices without air supply means, adapted to cause the material deposited thereon to pass to and above air supply devices; substantially as set forth."

Claims 5, 8, and 9 of No. 1,247,542 issued November 20, 1917, on application filed October 18, 1915.<sup>3</sup>

3 No. 1,247,542.

"5. The process of purifying sewage or analogous liquids, consisting in continuously supplying crude sewage or liquid and causing it to flow, aerating or oxidizing the same, depositing the sludge or solid matters from the liquid at a point where the liquid is not being aerated, continuously removing the treated liquid, and transferring deposited sludge or solid matters to the liquid at the part where it is being aerated or oxidized."

"8. The process of purifying sewage or analogous liquids, consisting in supplying crude sewage or liquid, causing it to flow, aerating or oxidizing and mixing it, depositing sludge or solid matters at a part where the liquid is not being aerated or mixed, removing the liquid from which sludge or solid matter has been deposited at this part, and transferring deposited sludge or solid matters to the liquid at the point where it is being aerated or oxidized.

"9. The process of purifying sewage or analogous liquids consisting in circulating and aerating or oxidizing the liquid simultaneously, and agitating the liquid at a part while circulating by particles of air discharged into its lower part so as to keep the sludge intermixed with the liquid, while at another part the liquid is not supplied with air and is in quiet flow, depositing sludge at this part, removing the clarified liquid, and transferring deposited sludge or solid matters back to the agitated circulating part."

[\*\*3] Claims 3, 7, 8, 9, and 10 of reissue No. 15,140 issued July 5, 1921, on application filed August 11, 1919. <sup>4</sup> (The original patent, No. 1,247,543 on which this patent was based was issued November 20, 1917, on application filed October 18, 1915.)

4 Reissue No. 15,140.

"3. The process of purifying sewage or analogous liquids, consisting in gradually supplying the crude sewage to a body of bacterial sludge or solid matter, aerating or oxidizing it while so being supplied, then allowing the liquid to remain quiescent, and gradually drawing off the purified liquid from near the surface, and leaving the sludge or solid matters."

"7. The purification of sewage or other impure liquids in which the liquid is treated or acted upon by bacterial sludge, separating sludge from the treated liquid, aerating such separated sludge for increasing the efficiency or activity of same; and returning such sludge to raw sewage or impure liquid which is being treated or purified.

"8. The method of purifying sewage and other impure liquids by the activated sludge process, by separating the sludge from the sewage or liquid which has been treated, aerating such sludge so separated for increasing the activity and efficiency of the bacteria of the sludge, and treating fresh sewage or liquid with such re-invigorated sludge.

"9. The method of purifying sewage or other impure liquids by the activated sludge process, by aerating raw sewage or liquid containing a substantial proportion of activated sludge; removing such liquid so treated; separating the sludge from the liquid; aerating the sludge so separated; and passing such sludge so revived or intensified to fresh sewage being aerated and purified, said operations constituting a practically continuous process.

"10. The improvement in the activated sludge method of treatment as applied to sewage, which consists in drawing off the activated sludge from previously treated sewage, aerating such sludge after its withdrawal to enhance the virility of aerobic organisms therein, and inoculating the raw sewage with such re-vitalized sludge."

[\*\*4] For brevity we shall adopt appellant's method of referring to the Jones United States patents by the last three digits of their respective numbers. All of these patents pertain to the treatment of sewage by aeration. No. 587 relates to apparatus, and [\*580] the others relate to process. It is admitted that 542 and 140 pertain to and depend upon the "Ac-

tivated Sludge Process." As to 540 and 587, appellee claims the same dependence, and appellant denies it.

It is claimed by appellee that the patents referred to are based upon certain British patents which were issued to Jones, that is to say: United States patent 540 is based on three British patents, 22,952, 729, and 19,916; No. 587 is based on British 19,916; No. 542 is based on British 22,737; and No. 140 is based on British 22,736. It is further claimed by appellee that the American patents are entitled to effective filing dates as of the dates of the applications for the British patents upon which the American patents are respectively said to be based.

Prior to 1912 bio-chemists generally understood certain processes of nature which are collectively designated as the "nitrogen cycle." In order to comprehend the subject [\*\*5] matter before us, and the contentions of the parties with respect to the claims in suit, it is necessary to describe that cycle in a general way, for it was by consideration of the natural laws therein involved that the successful disposal of sewage was attained.

Plant life grows by absorbing carbon dioxide from the air and food from the earth. That food must include certain simple nitrogenous compounds, such as nitrates and nitrites, which in turn are converted by the plants into more complex nitrogenous compounds. Plants become the food of animals whose life and digestive processes convert the nitrogenous compounds of the plants into still more complex nitrogenous compounds. When an animal dies, a process of putrefaction sets in, converting the most complex nitrogenous compounds of animal tissue into simpler ones, more or less soluble in water. Those compounds in solution are carried by the water into the earth where they are further reduced and converted into nitrates and nitrites ready again to become the food of plants. Of course much plant life dies and decays without ever being used as animal food, and in that case its nitrogenous compounds are more directly reduced. Again, [\*\*6] animal life does not necessarily have to die in order to start the process of conversion. The animal's excreta during life immediately become the subject of putrefaction, degradation, and conversion to the simpler nitrogenous compounds. The intermediate products of putrefaction are inimical to the existence of both plants and animals, hence it is essential that the putrefaction of both animal and vegetable life be followed by a process of purification by which it may be converted into the simple and wholesome compounds. Purification is largely a matter of oxidation which may be effected in time by exposure to air, or to running water which contains air, but oxidation by mere exposure to air is a very slow and offensive process.

For many years prior to the disclosures of the patents in suit it was known that bacteria performed an essential part in nature's processes of putrefaction and purification. It was known that anaerobic bacteria, those which live out of contact with air, attack animal bodies soon after their death, and promote the putrefactive processes which result in the conversion of the very complex nitrogenous compounds into the simpler and more soluble ones such as [\*\*7] ammonias, amidos, and aminos. These in turn are acted upon through processes of purification by aerobic bacteria, which thrive in the presence of air, and are converted into the nitrates and nitrites to be used again as plant food. It was also known that the absence of

air was inimical to the life processes of aerobic bacteria, while the presence of it was inimical to the anaerobic.

Appellee correctly defines purification of sewage as the conversion of the putrescent and putrescible, and perhaps other more or less complex nitrogenous, carbonaceous and sulphurous compounds into simpler compounds which are wholesome and inoffensive. This action involves ultimately the oxidation of the compounds, and a sufficient degree of oxidation means adequate purification. When all or a great proportion of the total nitrogen is reduced to nitrates and nitrites it is said that a sufficiently complete purification has been effected. This is not because the nitrogenous compounds are the only ones which require oxidation, but because they are the most difficult to oxidize, and when that is accomplished the carbonaceous and sulphurous compounds will of necessity have been sufficiently oxidized.

[\*\*8] Nature's process of purifying sewage involved the reduction of dead animal or plant life by putrefaction from its complex forms to the soluble compounds such as the ammonias, amidos and aminos. In these forms they could be dissolved in rain or other water and thus seeped into the earth or flowed over its surface into streams. Here these intermediate compounds came into contact with the aerobic bacteria contained in the surface soil and also upon the surfaces of [\*581] stones and rocks in running streams. In streams, these aerobic bacteria grew on certain slimy, gelatinous substances adhering to the stones and rocks, and absorbed the air contained in the running water. As a result of the contact between these bacteria and the intermediate nitrogenous compounds, the latter were further reduced to the simpler and more oxidized compounds such as nitrates and nitrites, and in this state, they had attained purification. These natural processes, although extremely slow, were quite adequate to effect requisite purification of a reasonable amount of pollution, but they were much too slow to effect or maintain the purification of streams and lakes into which the sewage of large cities [\*\*9] was poured.

How to dispose of abnormal amounts of sewage, caused by the growth of population and industry was a question that confronted the scientist and inventor from very early years, and it was never answered successfully prior to the disclosures out of which this controversy arises. Several methods of artificial sewage disposal were tried such as flowing over large areas of land, and contact filters, which include the trickling and sprinkling systems, through such media as tanks of rock, stone, cork, and sand. All such methods were very slow and expensive and proved to be quite unsatisfactory. Efforts were made to accomplish the desired result by chemical precipitation, but that method was likewise expensive and for that reason its extensive use was prohibited. No bacterial action was involved in it. In all those processes, except precipitation, nature's process was followed or approximated, and in each there remained after aeration and running off the liquid a sludge-like residuum of which no use was made. At the time the patents were issued it was known that this sludge contained both aerobic and anaerobic bacteria, and if permitted to lie dormant it would become septic [\*\*10] and fetid because of the activity of the anaerobic bacteria in the absence of air, but if kept in an active state it would become purified by reason of the activity of the aerobic bacteria in the presence of air. Thus the idea of activation of the sludge formed the basis of fur-

ther experimentation which resulted in the solution of the troublesome question. Its success was found to be dependent upon the fact that all sludge should be kept in active but gentle circulation with the sewage by the introduction of a continuous flow of air.

The patents in suit do not purport to cover the discovery of the bacteria, nor their characteristic activities, but they do claim the method and apparatus by virtue of which conditions are provided under which the aerobic bacteria are permitted to function to the best advantage. In certain experiments referred to, Mr. Eddy in 1903 and 1904, and Mr. Clark in 1912, actually purified sewage by aeration in the presence of sludge, but neither succeeded in reducing his experiments to commercial practice. The reasons for their failure are significant in that they appear to result from differences in the methods used by them and by Jones. Eddy failed because [\*\*11] his agitation of the sludge was too violent. Clark seems to have failed because of insufficient circulation, for his idea was to cause the sludge to settle upon many slate surfaces which he had placed in the tank in order to increase the stationary area of the gelatinous slime with which the sewage should come in contact. The deposits on the slate naturally increased in thickness and sloughed off and this in turn fell to the bottom where it lay quiescent and of course became septic. As a result of other laboratory experiments of his, algae were developed in the container and were permitted to grow, and they became enveloped with gelatinous slime, no doubt containing aerobic bacteria. Upon draining the water the algae and sediment were permitted to remain for contact with other fresh sewage. In all his experiments, so far as he professed to know, the bacteria were fixed and stationary, and no results were obtained which warranted commercial use.

Appellee says of the activated sludge system, which it argues is covered by the claims in suit, that it contemplates running sewage into a tank and there mixing it with a quantity of "activated sludge" which is a mixture of many species [\*\*12] of aerobic bacteria suspended in water. The bacteria adhere to the surfaces or pores of minute particles or flocs of zooglool or gelatinous material. The flocculi are suspended in the water and with it form a liquid which flows like water. One of appellant's witnesses described activated sludge to be a "uniform, flocculent suspension of the sewage solids accumulated from the suspended and colloidal solids present in sewage under aerobic conditions. \* \* \* It is rich in aerobic organisms, which have been developed by continued aerobic conditions in successive volumes of sewage." In amplification of that description, Mr. Eddy, in 1921, said,

"The floc is a sponge-like mass or an open-mesh network which in the process of [\*582] formation may envelop, entrap or entrain colloidal matter and bacteria. The spongelike structure of the floc offers a very large surface area for contact, and this floc appears to be able to absorb colloidal matter, gases, and coloring compounds. When the floc is driven about in the liquid it has a sweeping action by which the colloidal substances may be said to be swept out of the water, or as stated by Philip Morley Parker, the 'process may be regarded [\*\*13] as passing a filter through the water in place of passing the water through a filter.' Thus far the process seems to be primarily of a physical na-

ture. It has been demonstrated, however, that it can not be carried out under sterile conditions.

"Just what the action of bacteria and other organisms may be, is a subject which should receive further investigation. One plausible theory is that the bacteria which are contained in the cell-like structure of the floc, feed upon the very finely divided matter and thus relieve the floc of its burden of such substances and restore its faculty of absorption to such an extent that when introduced into the incoming sewage the floc efficiently performs its function of absorbing the colloidal matter which will again be consumed by the living organisms which thus cause its regeneration. Because of these properties the sludge has come to be called 'activated sludge,' a term suggested by Ardern and Lockett."

With this general statement of the earlier attempts at purification of sewage and of the knowledge of bacterial characteristics and their activities with respect to such purification, we shall proceed to describe the method which appellee claims [\*\*14] was disclosed for the first time by the Jones patents, and which it is admitted by both parties was invention and of revolutionary benefit to mankind.

According to patentee's method, the flocculent bacterial material and the sewage are thoroughly intermixed in a tank, the floor of which is partially covered with earthenware diffusers into which air is forced. Circulation and aeration are brought about by the effect of forcing the air through the very fine pores of the diffusers, causing it to be broken up into tiny globules which rise gently to the surface carrying with them the liquid thus impregnated, and thereby causing a downflow of the liquid at other portions of the tank. As the down-flowing stream returns to points above the diffusers, it is caused to rise again as it again becomes lightened by the tiny air bubbles. The effect of this is to keep the whole in constant, gentle circulation. The bottom of the tank at all points slants towards the diffusers and thereby prevents the deposit and permanent retention of any of the bacterial sludge or other solids, and the constant infusion of the air insures the aerobic conditions necessary to maintain the activity and vitality of [\*\*15] the bacteria of the sludge. After circulation and aeration for a few hours, until the nitrogenous compounds have been completely reduced, the aeration and circulation may be stopped, and during the period of quiescence, the liquid sludge settles rapidly to the bottom, after which the clear and purified water above the sludge is drawn off. The remaining sludge, if desired, may then be reactivated by a separate aeration which restores the vitality and activity of the bacteria. The reactivated sludge is then again mixed with fresh sewage and the same cycle of operations is repeated. There is practically no limit to the quantity of bacterial sludge with which a given volume of sewage may be intermixed, nor to the quantity of bacterial matter which may be made to attack a given volume of sewage, and complete purification is thereby attained in from four to six hours.

The successful practice of this method involves both process and apparatus. The more purely physical methods of aeration and circulation must of necessity be limited by certain

definite requirements. (1) There must be complete and continuous intermixture of sewage and sludge; (2) there must be no long continued deposit [\*\*16] of sludge which would permit septic conditions; and (3) the circulation and aeration must be so gentle as not to break up or destroy the flocculi. The apparatus must be adapted to meet those requirements. This is illustrated by the construction of the tank bottoms and the placement of the diffusers in such manner as to insure the return of the sludge to points above the diffusers; also optional means for the hospitalization or reactivation of the sludge, and also provisions for retention of sufficient water with the sludge after the settling operation to prevent a reduction of the bacterial vitality and activity by a too rapid dosage of fresh sewage. The method may be carried on in a continuous cycle, in which case the sludge is continuously withdrawn at the end of the cycle, reactivated if desired, and brought back to attack fresh sewage.

It is to be noted that in nature's processes and in all artificial filters of the prior art, [\*583] the aerobic bacteria were fixed, and the polluted water or sewage was brought to the bacteria, while in the activated sludge method, the situation is reversed, so that the bacteria instead of being fixed are put into circulation and brought [\*\*17] to the sewage.

It is true that Jones' method makes use of the scientific discovery that aerobic bacteria can live and thrive in or about the pores of microscopically small, spongy particles of flocculi or zoogloeal matter which in turn can be derived from sewage itself by long continued aeration under appropriate conditions, but that is not the subject matter of his patents. The invention is of physical methods and apparatus for handling, treating, and controlling the sewage and the bacterial flocculi in such a way as to promote the development and activity of the bacteria and to bring the bacterial matter into play in a new and different way, and it is upon disclosures with respect to those matters that the claims are based.

As against those claims appellant contended on the trial, (1) that the process claims were invalid because earlier invention must be ascribed, not to Jones and his alleged collaborators at Manchester, England, but to Clark at the Lawrence Experiment Station in Massachusetts in 1912 or 1913, and also to Eddy at Worcester, Massachusetts in 1903; and if not, then (2) the invention of the process is not attributable to Jones, but to Fowler, Ardern, Lockett and others [\*\*18] without participation by Jones; (3) that the claims with respect to apparatus embody only subject matter which is old in the art.

It is not contended here, however, that Clark or Eddy was the discoverer or inventor of what is now known and practiced as the Activated Sludge process, and the evidence before us falls far short of supporting such a contention if made. Clark's slate depositories did not produce the desired results, nor did the growths of algae, for the reasons already stated, and those processes were abandoned by him. The slate process was also tried by appellant without avail, and it likewise abandoned it. The only manner in which Clark can be said to be identified with what may now be called the perfected process, is the fact that Fowler, a resident of England, visited Clark's laboratory in November, 1912, and observed his work and its results, and from that observation acquired what he, Fowler, termed as an "illuminating idea."



The principal question for our consideration, therefore, is whether Jones is the rightful patentee or whether those whom Jones claims to have been his collaborators are in fact the rightful inventors independent of anything which Jones may [\*\*19] have done. This necessitates a setting forth of the relationship of those men and their activities during the time in which the patented process was being evolved.

Jones, a member of the firm of Jones and Attwood, had had a long and successful career in the invention, manufacture and distribution of apparatus for sewage purification. He was also the recognized manager, director and financial support of the syndicate which worked out and exploited the Activated Sludge System. Fowler was a professor in the University of Manchester, England, where he had a private laboratory, and from 1899 to 1904, was superintendent and chemist of the Manchester Corporation Sewage Works, and from 1904 to 1916 was consulting chemist for the Rivers Committee of that corporation. In October, 1913, he first met Jones from whom he accepted employment as consulting chemist, although that fact was not known to the city of Manchester or the Rivers Committee of that city for almost a year afterwards. Mumford was Fowler's personal assistant at the University in 1912 and 1914. Ardern, from 1909 to 1916, was assistant to Fowler as chemist for the Rivers Committee of Manchester, and after 1916 he was either [\*\*20] chief or consulting chemist for that committee and a full time employee of the city. Lockett was the research chemist for the Manchester Rivers Committee and a full time employee. In 1906 he was made assistant chemist, and from 1909 to 1915 he was the assistant of Fowler and had actual charge of the experiments carried on in collaboration with Ardern at the Davyhulme Works of the city of Manchester. Coombs in the early part of 1913 was employed by a manufacturing concern near Manchester, and while there he became fully acquainted with what was styled by Mumford as the M-7 process, the letter referring to the first letter of his name and the number to his laboratory culture of that particular aerobic bacillus which he was using in his experiments. Coombs was consulted by Fowler for the purpose of having Coombs' employer supply aeration equipment which was paid for by the city of Manchester and put into operation at the Davyhulme Works between September 20 and 26, 1913. On September 22, 1913, Coombs was employed by Jones and Attwood.

Upon returning to England from Clark's [\*584] laboratory in December, 1912, Fowler told Ardern and Lockett of the process which he had there [\*\*21] observed. He suggested a repetition of Clark's experiments with respect to aeration and leaving the sediment in the bottom of the bottle, but gave instructions to prevent the growth of algae by covering the bottle with brown paper. Experiments along the line of those suggestions were begun in January, 1913, by Ardern and Lockett under the supervision of Fowler, at the Davyhulme Works, and they were continued with variations during the year 1913 and a part of 1914. During that time Fowler and Mumford were conducting experiments at the University of Manchester in the M-7 process in which sewage was mingled with an aerobic bacillus known as M-7, and iron salts, to obtain its purification. This was carried on with apparatus purchased by the city of Manchester in May, 1913, at Fowler's request. Prior to July 7, 1913, Fowler and Mumford had sufficiently experimented with M-7 bacillus in continuous flow tanks aerated with equipment provided by the city of Manchester, to make a disclosure

of it on that date in a paper read by Fowler and first published on August 22, 1913. That paper disclosed that its authors' experimentations related to the nature and reactive qualities of a certain [\*\*22] aerobic organism which seemed to exercise a specific action on iron solutions in a precipitative way, and in carrying out their experiments, they had used factory sewage which contained inorganic elements such as iron. It was found that that organism required albuminoid organic matter to promote precipitation, and it was concluded that ordinary sewage could be used for that purpose. Experiments showed the possibility of clarifying sewage effluent in this way in the presence of a small quantity of ferric salts, provided aerobic conditions were maintained in the liquid by a current of air. The grosser solids were first removed by well known means of sedimentation in such manner as to cause the least amount of putrefactive change in the liquid portion of the sewage. The effluent was then led to a second tank where a small dose of ferric salts was added and a current of air maintained until clarification set in. Then the clear liquid was run off either for rapid final filtration or for direct discharge into the stream. The precise mode of action of the organism was not fully worked out at the time of reading the paper, but the likelihood of some organic conversion concurring with the [\*\*23] precipitation was suggested.

With the consent of the city, Fowler interviewed Coombs, explaining the M-7 experiments, and made arrangements with him to design, and for his company to supply to the city a second set of aeration equipment for carrying on the M-7 work at Davyhulme. This was before Coombs entered the employ of Jones and Attwood, and the equipment was installed at Davyhulme in September, 1913.

There is no doubt that all the bio-chemical experiments, analyses, and tests relating to the subject matter of the patents and leading up to their disclosures, were conducted at Davyhulme or at the University of Manchester. Appellee contends, however, and the trial court found, that Fowler, Ardern, Lockett, Mumford, and Coombs were collaborators of Jones who in fact was the discoverer and inventor of the method and apparatus. On the other hand, appellant insists that Jones merely pirated the conception from Fowler, Ardern and Lockett, the real inventors, upon information received by him from Fowler and Coombs who came into his employ during the period of experimentation, and from the public disclosures of Ardern and Lockett whom he had never met. Hence, appellant says that Jones [\*\*24] was not the inventor and did not believe he was the inventor when he filed his applications for the patents, and was therefore not entitled to them.

The disclosures of Ardern and Lockett just referred to were in the form of papers prepared by them and read before scientific societies, relating to their experiments in the purification of sewage at the Davyhulme Works. The first, and perhaps the most important one with respect to this controversy, was read by Lockett before the Manchester section of the Society of Chemical Industry on April 3, 1914, disclosing the results of the investigations in which they had participated at the Manchester laboratory beginning January 3, 1914. It was published for the first time, May 30, 1914, and widely distributed. The work was of an entirely scientific character and the authors of the paper did not and could not disclose or claim inventive process for it. The disclosures were bio-chemical in their nature and there was no

suggestion as to how they could be translated to a practical working basis. That fact is established not only by the paper itself, but also by the thorough discussion which followed its reading. It is further established [\*\*25] by the fact that when, early in August, 1914, the first Ardern and Lockett paper and the Fowler and Mumford paper [\*585] came into the hands of Mr. Hatton, the chief engineer of appellant's Sewerage Commission who subsequently developed appellant's plant, he was unable to translate their contents to a practical working basis from their contents alone. We find him writing to Mr. Fowler on September 14, 1914, asking for such descriptions of the process and results as would enable him to fully comprehend the process which Fowler was using, and later for further information with respect to the installation of appellant's plant. This correspondence began with a letter from Fowler to Hatton on July 27, 1914, enclosing the first Ardern and Lockett paper and the Fowler and Mumford paper in which letter it was stated, "I think you will be interested in the enclosed paper describing recent experiments on the purification of sewage by aeration. Work is being pushed on, and promises (to) lead to very valuable results." This would clearly indicate that as late as July 27, 1914, the desired method of translating the biochemical process had not been determined by Fowler, Ardern, Lockett or [\*\*26] Mumford.

There can be no doubt that shortly after Coombs was employed by Jones on September 22, 1913, Jones at the suggestion of Coombs became interested in the M-7 bacillus which had not then been reduced to successful commercial use, and in fact never was. Jones was not a scientist in the field of bacteriology or bio-chemistry, but he had had large experience in problems involved in sanitation. He evidently did not essay to study and solve problems of bio-chemistry as such, but he did interest himself in the development of processes, and in this it is obvious that he had to associate himself with others familiar with the technical scientific problems involved and able to help him translate their theories into practical processes. Hence, during the fall of 1913, he, with the aid of his employee Coombs, was persistent in his efforts to develop a method to utilize the M-7 bacilli commercially in the purification of sewage, and on October 11, 1913, he filed his provisional specification for a British patent, No. 22,952. Regardless of the fact that he was then engaged in and may have intended to continue the study of M-7, and contemplated aeration in the presence of chemicals, the [\*\*27] application discloses a clear conception of the bio-chemical theory and a process (1) to increase aerobic activity, and (2) to keep solids in circulation with the liquids, this without limiting his claims to M-7 or any particular kind of aerobic bacteria, or to the use of chemicals of any kind. Within two weeks from the date of this application, Fowler was employed by Jones, further experiments were conducted at Davyhulme under Fowler's direction, improved facilities for experimentation were established, and a different type of sewage was resorted to. These experiments show the use of a measured proportion of sludge, and in November, 1913, the term "activated sludge" was first used, although it was not published until the following spring. On November 20, 1913, Fowler wrote Jones, "\* \* \* Matters are developing rapidly at Davyhulme and the possibilities seem even greater than we thought \* \* \*." On November 24, he again wrote to Jones, "Briefly the position is this. We find the M-7 process is part of a larger cycle applicable to raw sewage \* \* \*."

On January 10, 1914, Jones filed his application with a provisional specification for British patent No. 729 for improvements in apparatus [\*\*28] in which he declared: "In the purification of sewage it has been found desirable to bring and keep certain forms of bacteria and other life found in or added to the finely divided particles of sewage sludge into intimate contact with and equally dispersed throughout the whole of the liquid portion of the sewage and in the presence of suitable chemicals and of ample atmospheric oxygen. The tendency is for the heavier solid matters to settle to the bottom of the tank, and this invention provides means for preventing this settlement and for keeping the whole in motion for any desired period of time, and for aerating it until the process is completed." The complete specification was filed July 10, 1914. It refers to the "process of a cultivated sludge" and expresses the desirability of bringing and keeping the bacteria and other germ life existing in the sludge into intimate contact with, and equally dispersed throughout the whole of the liquid portion of the sewage.

On April 3, the first Ardern and Lockett paper was read and its disclosures were admittedly revolutionary in their bio-chemical aspects. Fowler, Lockett and Coombs were present but Jones was not, and it is contended by [\*\*29] appellant that the first information Jones had of its contents and scope was from his employee Coombs. However, the intimate relations which Jones had with Fowler after the latter's employment by Jones in October, 1913, and the correspondence which passed between them seems to negative the reasonableness of that contention. This conclusion is also corroborated by the record [\*586] which discloses that the reading of this paper was discussed beforehand, as to who should read it. Jones and his company were contemplating commercializing the activated sludge process and equipment for profit. Since Fowler was in Jones' employ and no doubt anticipated sharing those profits, having agreed to accept stock in the concern, he could not read the paper before the scientific body without violating his professional ethics as a scientist, as it would savor of advertising his own wares on which he expected material profit, and if that fact were disclosed it might jeopardize his standing as a scientist. Ardern had been offered employment by Jones, but he is said to his credit, he refused because it would have conflicted with his full time employment by the city. It was under these conditions [\*\*30] that Ardern was chosen to read the paper. Appellant, however, does not deem this testimony worthy of credit because of what it terms Fowler's bad conduct in surreptitiously accepting employment by Jones when he was a part time employee of the city, and performing all his experiments at Davyhulme at the expense of the city. His actions in that respect, indeed, do not appear to be commendable, but that was a matter which concerned the city and not appellant, and the evidence discloses that it was amicably adjusted later. If it be conceded, however, that appellant is correct in its appraisal of Fowler's character, we are reluctant to believe that he would have stood by without objection and permitted Jones to secure a patent on means and apparatus which Fowler thought he himself had invented, even though it might result in a forfeiture of his membership in the scientific society, or affect his scientific standing.

On April 11, following the reading of the Ardern and Lockett paper, Jones filed the complete specification under British patent No. 22,952, the application for which, with a provisional specification, had been filed on October 11, 1913. On September 17, 1914, he

filed a [\*\*31] complete specification under British patent No. 19,916. On November 19, 1914, he filed applications for British patents Nos. 22,736 and 22,737, and on May 19, 1915, he filed complete specifications under them. All these, like their predecessors, disclose processes and apparatus which show a clear conception of the theories developed in bacterial research, which taken together are clearly the bases of the American patents in suit, and reflect and adequately claim the activated sludge process and apparatus essential to its practice as it has been recognized.

A short time prior to October 24, 1914, the Rivers Committee of Manchester learned for the first time that Fowler was in the employ of Jones and had been for about a year. That fact occasioned considerable feeling between the committee and Jones and Fowler lest the city should be compelled to pay a royalty on the patents which in fact had been developed at Davyhulme and largely, if not entirely, at the expense of the city. An amicable adjustment was effected whereby patentee issued a permit to the city to use the process and apparatus without payment of royalties, and agreed to furnish the city any apparatus it desired at cost [\*\*32] plus ten per cent. That agreement we understand from the record is still in effect. The British patents referred to covering process and apparatus were issued to Jones. We find no evidence in the record to indicate that anyone in England, whether a collaborator of Jones or not, has ever successfully contested his right to those patents, or contended that their claims do not cover and read upon the process of "activated sludge" as it is now practiced. It is true that Lockett's testimony at the trial attempted to create the impression that he alone was the discoverer and inventor as a result of experiments conducted by him in the early part of 1913, yet when later confronted with his dated laboratory notes, he was forced to admit that the experiments to which he referred were conducted in the latter part of that year. None of the witnesses confirmed his claim that he was the inventor, and he was the only one of the experimenters at Davyhulme or Manchester University who questioned Jones' right to that title. It is submitted that Fowler in his testimony only partially supported Jones' right to the title of inventor of the subject matters covered by the patents, and that he stated [\*\*33] that Jones was not the inventor of the process. If this be conceded, it is quite obvious from all the circumstances including other statements of his, that he was speaking of the bio-chemical process involved in the patents and not the method or commercial process by which the bio-chemical process was induced to perform its perfect work. This conclusion we think is supported by the following statement of Fowler: "It was after I met Mr. Walter Jones that real progress took place in the translation from what had been a merely scientific and laboratory discovery into a practical commercial process; when I say 'commercial' [\*587] I mean one that is capable of being carried out in a practical manner on a large scale." And again, "It was only after I had come into touch with Mr. Walter Jones that devices were used which kept the sludge in a fine state of division, that is to say, prevented large adherent masses accumulating anywhere, which moved it throughout the liquid in a regular path and which prevented any deposit in any part of the containing tank."

We are not at variance with the following principles of law relied upon by appellant:

A valid patent can be granted only to an [\*\*34] actual inventor.

The application must be made by the original and first inventor, supported by his oath.

Generally speaking, one is not entitled to patent the discovery or invention of his employee.

When a number of persons make an invention jointly, a valid patent can not be taken out in the name of one of them. But when a person has discovered an improved principle and employs other persons to assist him in carrying it out, and they in the course of experiments arising from that employment, make valuable discoveries ancillary to the plan and preconceived design of the employer, such suggested improvements are in general to be regarded as the property of the party who discovered the original improved principle, and may be embodied in his patent as a part of his invention. *Agawam Woolen Company v. Jordan*, 7 Wall. (74 U.S.) 583, 19 L.Ed. 177; *Larson v. Crowther* (C.C.A.) 26 F.(2d) 780.

Our attention is directed to certain statements made by Jones in which he attributed the discovery of the activated sludge process to Fowler and his colleagues, and characterized his own firm's activities as that of designers and makers of apparatus for carrying out the process. That Fowler and [\*\*35] his assistants at Davyhulme discovered the biochemical process there can be no question, and we think that process is the one contemplated by Jones when he attributed the discovery to Fowler. Moreover, a reading of the evidence convinces us that that process is the only one which any of the scientists, except Lockett, ever claimed to have discovered. It is worthy of note that at that time his claim for a British process patent was pending and had been on file since November 19, 1914.

We must not lose sight of the fact that the issuance of the British as well as of the American patents created a presumption that Jones was the rightful inventor. In view of the supporting evidence of Fowler, Ardern, and Coombs, and the fact that the city of Manchester recognized Jones as the inventor by accepting a license under the patents, we can not say that that presumption has been overcome. At the time the permit was issued, the scientists at Davyhulme and the officers of the city of Manchester no doubt were as well informed as to the facts as anyone, and with their stamp of approval upon Jones' right to the invention, we think the court after fifteen years have elapsed may well be reluctant [\*\*36] to differ with them on a mere question of fact, and this is especially true in view of the fact that Jones and also Mumford had died prior to the trial.

We are therefore constrained to believe that Jones was the rightful inventor of the process and apparatus as described in his British patents, and that Fowler, Ardern, Lockett, Mumford and Coombs and all other collaborators at Davyhulme and the University must be considered as ancillary discoverers under the rule laid down in *Agawam Woolen Company v. Jordan*, supra. We are convinced that when Jones filed his application for the patents in suit, he believed that he was the original and first inventor, as required under Revised Statutes, § 4923 (35 USCA § 72).

The British patents are not directly in issue here, except as they may constitute the bases of and furnish effective filing dates for the American patents. It is true that Jones' earlier patents make no claim of broad novelty in a process or apparatus to raise and at the same time

aerate sewage and other liquids by forcing compressed air into the lower end of a pipe which dips into the liquid, or to deliver air or gases into sewage in a vessel in minute bubbles by forcing the [\*\*37] air or gases through porous stone or the like in the bottom of the vessel. Appellant therefore contends that the basic concepts embodied in the British patents are unrelated in specifications and claims to those embodied in the American patents, but with that contention we can not agree. We think the evidence clearly discloses that all the patents, both British and American, have a very close relationship in the art, and constitute a series or succession of patents in one continuous effort in the development of methods and apparatus with respect to the activated sludge process, and that development kept [\*588] pace with the bio-chemical discoveries. As usual, in cases where such relationship exists, the problem of precisely determining in a single case what, if any, portions of the specifications or claims of the later patents embody recognition and adoption of disclosures of the earlier patents, is not easy to solve. For that reason the patents should be considered collectively, and if from such consideration the patents may be reconciled upon disclosure of novel additions in the later not found in the earlier which were deemed entitled to recognition, it may not be necessary, [\*\*38] and in this case we think it is not necessary to determine exactly all points of mere contact or of overlapping of one as against another patent. Kraft Cheese Company v. Pabst Corporation (D.C.) 17 F.(2d) 787.

We are in full accord with the following statement of the trial court: "The patents in suit, upon fair reading, plainly go back to their respective British predecessors, not always wholly to one in particular, but to one or more of them in aiming to disclose subject matter which, either as to process or apparatus is found in the latter, and which in turn reflects or reflect the course of development back of any and all such Manchester work. It is my judgment that the patents in suit, in their disclosures of apparatus have the same security against successful attack which is based upon any prior patents or publications. \* \* \* The interest in the matter stimulated by the discovery of 'M 7,' did not justify placing any limitation upon the subsequent efforts nor require that that specific interest be segregated from the larger interest in truth manifested by Jones and his associates in the fall of 1913. On entirely elementary principles, a patentee or claimant of invention is [\*\*39] not put to the peril of disclosure of the highest degree of perfection or of perfectibility of his conceived apparatus. Wherefore, if Jones for a time conceived that his apparatus was organized for the dual purpose of carrying out his thought respecting 'M 7,' and also the larger thought suggested in the Fowler and Mumford paper; and in the process of research and experiment concludes that the 'M 7' thought must give way to the 'larger cycle,' it is difficult to see upon what ground the adequacy and novelty of his apparatus for the then conceived larger process can be disparaged or denied, if the latter be established. Plainly, in view of the continuity of the work as described by Jones, Fowler, and their associates, the disclosures in an application filed October 11, 1913, should not now be imputed to the applicant as excluding their novelty and availability in the larger purpose then unquestionably the subject of their endeavors, likewise (the same may be said) with reference to the applications filed in January and April, 1914."

Appellant has cited numerous prior art patents and publications which it contends anticipate the patents in suit. To discuss these at length we think [\*\*40] would unnecessarily prolong this opinion without serving any good purpose. Some of them are taken from non-analogous art; others do not contemplate organized and restricted currents of air; most of them do not involve regulated and continuous circulation nor contemplate bacterial action, and in our opinion, none of them, including the work done at Manchester and in Massachusetts and the publications regarding them, is capable of satisfactorily carrying out any of the methods disclosed in the patents in suit. If it could be said that certain prior art apparatus is capable of carrying out appellee's process, which we do not concede, it would add nothing to appellant's contention, because a process patent is not anticipated by apparatus which may be used to carry out the process. *Tilghman v. Proctor*, 102 U.S. 707, 26 L.Ed. 279; *New Process Fermentation Company v. Maus*, 122 U.S. 413, 7 S.Ct. 1304, 30 L.Ed. 1193; *Expanded Metal Company v. Bradford*, 214 U.S. 366, 29 S.Ct. 652, 53 L.Ed. 1034. If it be conceded as appellant contends, that each element of the apparatus patent is old in the art, we think it can not be denied that they are here used in such manner as to produce a new and useful [\*\*41] result, in a more efficient, economical and facile way.

It may also be conceded that the application of an old process or machine to a similar or analogous subject with no change in the manner of application and no result substantially distinct in its nature is not patentable invention; but we think the processes and machines which are claimed by appellant to be anticipatory are quite different in their manner of application, and their results are substantially distinct in their nature from those of the patents in suit.

It is contended by appellant that knowledge of the activated sludge process at Manchester was complete in the United States more than a year prior to the filing of any of the applications for the American patents which have anything to do with the [\*589] activated sludge process, and months before British applications alleged to correspond therewith were filed in Great Britain. Notwithstanding the fact that the bio-chemical process described in the Ardern and Lockett paper was sent to the United States, and that information concerning the tank at Manchester, designed by Jones, and observed by one of appellant's witnesses, and other information obtained by another [\*\*42] witness of appellant from Dr. Fowler were all communicated to others in the United States prior to the applications for the American patents, the contention can not be sustained. Reduction to practice in a foreign country or a previous foreign invention can not operate to invalidate a patent granted in the United States unless the foreign invention has either been patented or described in a printed publication, neither of which conditions existed here. 35 USCA §§ 31, 72; *Westinghouse Machine Company v. General Electric Company (C.C.A.)* 207 F. 75.

Appellant contends that the British applications of October 11, 1913, January 10, 1914, and April 11, 1914, related only to the utilization of the M-7 bacterium which is not in any way related to the activated sludge process, and that inasmuch as United States patent No. 540 is based upon these British applications, the conclusion must follow that patent 540 is likewise limited to the M-7 bacterium. It further contends that all American patents based



on British applications filed later than May 30, 1914, are anticipated by the Ardern and Lockett paper which was first published on that date. A perusal of the applications for the British [\*\*43] patents upon which 540 is based is quite convincing that they describe the process employed in the utilization of all the different varieties of aerobic bacteria of activated sludge, and it can not be said that they are limited to the M-7 bacteria. We are convinced that the first Ardern and Lockett paper does not disclose and anticipate the subject matter of the claims of the later patents. If it be conceded that the second Ardern and Lockett paper and the Melling paper, which were first published on December 15, 1914, disclose the subject matter of those claims, they are not effective against the United States applications based upon the British applications of November, 1914.

Appellant contends that none of the apparatus disclosed in the drawings of the Jones patents in suit ever went into commercial use in the precise forms there shown. The evidence we think quite strongly refutes this contention. The Jones process was susceptible of being applied in many modes and by the use of many forms of apparatus, and the inventor was not bound to describe them all in order to secure to himself the exclusive right to the process which he invented. *Tilghman v. Proctor*, supra.

It is contended [\*\*44] by appellant, and it may be conceded, that courts are not permitted for the purpose of saving a patent otherwise invalid to read into it a limitation of elements not contained in the claim. It must be borne in mind, however, that in the interpretation of claims they must be read in the light of their specifications, and when this is done with respect to the patents in suit we think the claims are sufficiently complete to comply with the rule laid down in *Permutit Company v. Graver Corporation* (C.C.A.) 43 F.(2d) 898.

We are convinced that the trial court correctly held that Jones was the original, first, and sole inventor of the patents in suit; that the claims charged to be infringed are valid claims; and that the patents in suit are entitled to effective filing dates as of the filing dates of the British patents upon which the American patents are respectively alleged to be based, in accordance with sections 32 and 80 of title 35 of the United States Code.

The question is presented as to whether appellant is guilty of infringement. On August 10, 1914, Hatton answered Fowler's first letter expressing particular interest in the papers which Fowler had sent him, because, as he stated, [\*\*45] he was then engaged in designing a sewage disposal plant for appellant. He further stated that preliminary to making the design he was going to carry out a year's experiment on behalf of the city on several different processes of sewage purification, including the slate process, and he hoped to have their testing station in operation by September 1. Following Hatton's request, on September 14, for further descriptions of Fowler's process, further correspondence ensued between them relative to a retainer for Fowler from the Milwaukee Sewerage Commission. Before that matter was settled, Hatton, on October 14, wrote Fowler asking him many questions relative to the working and installation of the process, and from his letter it is quite obvious that Hatton had derived but little aid, if any, in those respects from the Ardern and Lockett and the Mumford papers. Those questions were answered by Fowler on November 2, 1914, and at the same time he suggested a fee of \$1,000 for himself which [\*590] should be considered

as a part of a larger fee should the process be finally adopted on a larger scale. On January 8, 1915, before anything had been done toward the construction of appellant's [\*\*46] experimental plant, Fowler wrote to Hatton that he had interviewed Coombs, engineer of Jones and Attwood, with respect to Hatton's plans; that he had consulted Jones and Attwood in September, 1913, on the mechanical engineering of the new process, and found that the critical point in it was the injection of air through a specially designed porous tile known as a diffuser, which, with the method of its use, had been patented in England and other countries including the United States. On February 9, 1915, Fowler sent Hatton a drawing by Jones and Attwood of the proposed conversion of the Milwaukee sewage tank for the activated sludge process, which gave full information for the construction of an experimental plant.

In correspondence which passed between Hatton, and Jones and Attwood between February 9, and July 31, 1915, the Jones patents were discussed, and Jones and Attwood requested a royalty or commission of \$250 for a license on the experiment plant which Hatton proposed to construct at Milwaukee. The United States patents had not yet been granted and the character of the claims which would finally be allowed had not been determined. It seems that up to this time Hatton had [\*\*47] not been informed of Fowler's employment by Jones and Attwood, and on July 31, 1915, he wrote to Fowler expressing surprise at the request of Jones and Attwood with respect to the experimental station at Milwaukee, and stated that the design of that station was entirely original and conformed with those features of the process which they had tried out in collaboration with Fowler and for which they had from time to time sought Fowler's advice; that so far as Hatton could determine from Jones and Attwood's plans and pamphlet there was no part of the same being used in the experimental plant except the general process of activated sludge; that if they were infringing he assumed that Fowler's association with the Milwaukee experiments carried with it his consent to trying out the process to a final determination without royalty or commission; that if at that time the Milwaukee process and plans should prove to be an infringement upon any United States patents, then the discussion of royalties and commissions would be pertinent, but up to date, he said that time was far from being reached.

Up to that time it is conceded that Hatton in his experiments had departed quite largely from the [\*\*48] appearance of the plant which had been suggested by the plans of Jones and Attwood, but it is contended by appellee that Hatton returned to the Jones and Attwood plan when he constructed the present Milwaukee plant. The parts of the plant which are pertinent to the issue may be briefly described as follows: Raw sewage is brought to the plant through two sewers and passes through the grit or sediment chambers and the fine screen house to the mixing conduit. Activated sludge flows into this conduit from the sludge pumping station in an amount equal to twenty per cent. of the total mixed sludge and sewage. The sludge and sewage are circulated and aerated by means of diffuser plates in the bottom of the mixing conduit. From this conduit the mixed liquor is discharged proportionately into each one of twenty-four aeration channels or tanks, twelve of which are located on one side of the sedimentation tanks, and twelve on the opposite side, all extending lengthwise from the sides of the plant toward the center. Each aeration tank has two parallel com-

partments, each being 236 feet long, 22 feet wide, and 15 feet deep, and formed with ridge and furrow bottom. The compartments of each [\*\*49] tank are separated by a central longitudinal partition which extends from the inlet end to within about twenty-two feet of the outer end of the tank, so that the mixed sewage and sludge will flow from the inlet compartment into the parallel outlet compartment with uninterrupted velocity. The passage of the mixed sewage and sludge through the aeration tank requires about six hours after which it flows continuously from or near the top of the outlet end of the second compartment into channels and then over weirs, quietly and continuously, into large sedimentation tanks, where the sludge settles to the bottom. This bottom is pitched slightly toward the point from which the sludge is removed, and the continuous passage of the sludge from this chamber is assisted by slowly moving blades toward the center of the tank from whence it is continuously drawn into the return sludge channels. The moving blades, however, are not shown in the exhibited drawing of the Milwaukee plant. The purified and clarified effluent is continuously flowed from the top of the sedimentation tanks into Lake Michigan.

The sludge which settles to the bottoms of the sedimentation tanks flows through channels and [\*\*50] thence through subterranean conduits [\*\*591] to the sludge pumping station. From there it is raised to a higher level by means of return sludge pumps and returned to the point at which the treatment is commenced, where it is introduced into the incoming raw sewage as before described. The return sludge channels are provided with diffuser plates for the dual purpose of re-aerating or reactivating the sludge and preventing its deposit upon the bottoms of the channels where if allowed to accumulate it would become septic. The ratio of diffuser plate area to the area of the sewage surface in the feed and mixed liquor channels is approximately the same as that in the aeration tanks, about one to four, and the return sludge channel is provided with diffuser plates in the ratio of one to six. (In the plans received by Hatton from Fowler the ratio was about one to five.) More sludge is produced than is necessary for the continued treatment of raw sewage, and that excess is withdrawn from the sludge conduit through another subterranean conduit and made into commercial fertilizer. The diffuser plates in the aeration chambers of appellant's plant extend cross-wise of the channels in complete [\*\*51] rows, except for a break through the center of the channels where a complete line of diffuser plates extends from one end of the channel to the other to facilitate draining. All diffuser plates are located at low points between the ridges of concrete. The typical path of sludge flow is upward over the first line of diffusers, then downwardly with a return to the same diffuser throughout a number of circulations, then over the second line throughout a number of circulations, and so on until each particle theoretically has circulated a number of times over each line of diffusers from the beginning to the end of the aeration tank. However, few if any particles of sludge follow the typical path, but most of them may be diverted many times in their course through the aeration channel, and turned backward by the current in which they are travelling into the current of a preceding diffuser. The cross sectional area of the rising currents over each row of diffuser plates is sufficiently large to maintain a flow of sewage and sludge down the slopes of all the ridges at sufficient velocity to prevent the deposit of sludge on the slopes and to keep all of

the sludge in continuous movement [\*\*52] during the entire period it remains in the aeration tank.

It is obvious that claims 2, 3, 7, 11, and 13 of patent 540 describe appellant's process quite clearly. Appellant's diffusers spaced along the bottoms of the aeration channels, cause an upflow, lateral flow, down flow, and sweeping flow along the sloping floors of the aeration channels, thereby returning the sewage sludge to the air currents from the diffusers, and thus causing an intimate mixture of all the sludge with all the liquid as described in claims 2, 3, and 7 without reference to the flow of the sewage and sludge through the channels. The removal of the clarified liquid as called for in claim 3 is accomplished in appellant's sedimentation tanks. The plurality of points for the introduction of air, referred to in claim 11, corresponds to appellant's succession of rows of diffuser plates separated by ridges, and the introduction of air locally into the liquid provides the aeration and circulation referred to in the latter part of that claim, which describes the path of a typical particle of sludge or sewage. That path, however, is created not only by the up and down flow caused by the rising currents of air, sewage, [\*\*53] and sludge, but also in part by the general flow through the channels from one circulation and aeration action over one line of diffusers to successive similar sections over other lines of diffusers, as described in claim 13.

Patent 587 is a division of the application resulting in patent 540. Claims 2 and 8 are directed to apparatus in which the bottoms of the aeration chambers are sloped toward the diffusers for the purpose of directing the sludge or solid matters to positions over the diffusers.

In appellant's device the ridges on the bottom which extend across the channels of the aeration units correspond with the ridges in the patent which divide the tank bottoms into hoppers rather than channels, but claims 2 and 8 of this patent are not limited to four sided hoppers and describe appellant's channels, or two sided hoppers, quite clearly. The function of each is precisely the same, it is accomplished in the same manner, and the result of each is identical. The spacing of the diffusers is not substantially different and produces the same effect, and the tank or aeration chamber of the patent as described in claims 2 and 8, we think, may fairly consist of one channel or appellant's [\*\*54] unit of two channels.

Patent 542 relates to the continuous sludge return wherein the sludge passing over the weir with the effluent is permitted to settle in a separate chamber, the sludge being drawn off from the bottom while the clear effluent flows off at the top of the chamber. The settlement tank may be provided either [\*592] with a slope sufficient to carry the activated sludge to the low point of exit from which it is removed gently as by an air lift mechanism, or it may be quietly scraped toward the point of discharge, in which case flat or substantially flat bottomed tanks may be used. In either event a portion of the sludge is returned to the aeration chamber, either by way of a re-aeration or hospital tank, or directly. The remainder is either drawn off separately for irrigation purposes, or permitted to pass away with the effluent. Reference to claims 5, 8, and 9 of this patent convinces us that they fully cover the elements above set forth, and that they are infringed by appellant's process.

With respect to reissue patent No. 140, claim 3 relates to the gradual administration of raw sewage to the activated sludge in order to avoid the sudden shock which impairs [\*\*55] the vitality of the sludge. This gradual administration is accomplished with a substantially continuous flow by providing several tanks into which the sewage is run one after the other including a hospitalization tank, into which the sludge alone is run and revitalized before it again comes in gradual contact with the raw sewage. In appellant's plant raw sewage is run into the aeration tanks in conjunction with activated sludge which has just returned from the settlement chambers through aerated re-activation channels. This sludge enters the aeration channels where it immediately commingles with other sludge which has been in the aeration chambers for some time, and it there also commingles with sewage, not all of which is raw, even at the entrance of the aeration channel, due to the continuous mixture of sludge and sewage in the aeration chamber caused by a continuous flow of air from the diffusers regardless of the general flow of sewage and sludge through the aeration chamber from its inlet to its outlet.

The principle upon which claim 3 of this patent is based is that all the particles of activated sludge shall not be suddenly submerged in undiluted raw sewage, and appellant's [\*\*56] process accomplishes this by having the raw sewage enter a chamber which already contains a large proportion of partially treated sewage. Whether the gradual drawing off of the clear liquid from above the blanket of sludge is performed in the aeration chamber, as in a fill and draw method, or in a separate settlement chamber as used by appellant, we think makes no difference. The principle is the same and we think there is infringement.

Claims 7, 8, 9, and 10 of this patent relate to the re-aeration of the activated sludge. It is obvious that this principle is carried out, in a more or less degree, in appellant's plant by the air diffusers which are placed in the return sludge channels about seven hundred feet in length leading from the settlement tanks. Hatton attempted to minimize the effect of this re-aeration as used by appellant. He stated that these diffusers are for the purpose of aiding the flow of sewage back to the pump and preventing its settlement; nevertheless, in his testimony immediately preceding that statement he said that the flow of sludge in the return channels was aerated by itself and not in the presence of raw sewage. It is quite obvious that this is [\*\*57] true, and it is the precise principle upon which the claims now under discussion are based. If there be a difference in the use of that principle by appellant from that practiced by appellee under the claims it is certainly a difference in degree of aeration and not in substance, and it will be noted that the claims are not limited in this respect. A comparison of the ratio of diffuser plate area to the area of sewage surface in appellant's sludge return channels with the same areas in appellant's aeration tanks and with those in the aeration tanks suggested in the Jones and Attwood plans which were sent to Hatton, convinces us that the re-aeration in appellant's return sludge channels is quite substantial and infringes these claims.

It has been suggested that claims 7, 8, 9, and 10 of Jones' reissue patent 140 which bears the filing date of August 11, 1919, were filed to broaden the scope of the claims of the original patent 543 in order to include the previous work done at Milwaukee and by numerous

other cities in the United States. Under the evidence it is quite clear that no intervening rights can enure to appellant with respect to the reissue. The present Milwaukee plant [\*\*58] was begun April 26, 1920, and completed June 25, 1925. While the experimental plant was in operation before that time, we think the evidence does not disclose that appellant even experimented with re-activation prior to the filing date of reissue patent 140. Whether other cities have intervening rights with respect to this patent seems to us to be beside the question before us, for as we understand the law, an intervening right is one of which no one can take advantage except the party who is directly affected, unless the patentee waits so long to apply for his reissue [\*593] that he can be understood to have abandoned his patent to the public. See *Topliff v. Topliff*, 145 U.S. 156, 12 S.Ct. 825, 36 L.Ed. 658; *Mahn v. Harwood*, 112 U.S. 354, 5 S.Ct. 174, 6 S.Ct. 451, 28 L.Ed. 665. Such is not the case here.

Appellant contends that the court erred in permitting appellee to dismiss its bill of complaint as to patents No. 1,286,017 and 1,341,561, which were originally included in the complaint. The record discloses that notice of a motion to accomplish this result was served upon appellant before any depositions were taken, and we think the ruling was right under the authority [\*\*59] of *Ex parte Skinner & Eddy Corporation*, 265 U.S. 86, 44 S.Ct. 446, 68 L.Ed. 912.

Included in appellant's answer to the bill is a counter-claim for damages arising out of alleged threats of infringement suits by appellee and its agents against public corporations and municipalities including appellant. The record discloses no factual basis to support this counter-claim.

It is further contended by appellant that no accounting or injunction should have been ordered against appellant because no notice of infringement was given to it prior to the filing of the bill, and for the further reason that the sewage disposal plant was not built nor operated by appellant, nor did appellant have or exercise control of any kind over it, but that it was built, administered, and controlled by the Sewerage Commission of Milwaukee, a separate municipality, under and by virtue of an Act of June 30, 1913, of the Laws of Wisconsin (chapter 608). Appellant admits that it is a proper party by reason of its paternal interest in the welfare of its citizens, but denies that it is in any way liable to respond in damages for the acts of misfeasance or malfeasance of the Sewerage Commission. The notice of infringement [\*\*60] was served on the Commission on October 29, 1924, and the complaint was filed on June 15, 1928. Section 12 of the act last referred to, among other things provides that "any person or persons injured as the result of the location, erection and operation of the said sewage disposal plant or plants or any part thereof, shall be entitled to such damages from the city as such person or persons may suffer therefrom." This statute, together with appellant's paternal interest which it admits, is we think sufficient to render the notice valid as against appellant, and fully establishes its liability.

The decree in this case enjoins appellant from operating its plant. Ordinarily courts will protect patent rights by injunctive process. In determining whether that process shall be made permanent, the equities of all parties concerned should be considered. In the instant

case both parties have strong equities, and there are many others who are indirectly concerned whose equities are even stronger than those of the parties. The damages of appellee may be compensated by a money judgment, and yet it has been subjected to great delay, and perhaps may yet suffer further delay, and greater than [\*\*61] it otherwise would if the injunction were made permanent. It is only fair to say that these delays have been caused by the enormous amount of work necessarily occasioned by the issues involved. If, however, the injunction ordered by the trial court is made permanent in this case, it would close the sewage plant, leaving the entire community without any means for the disposal of raw sewage other than running it into Lake Michigan, thereby polluting its waters and endangering the health and lives of that and other adjoining communities. It is suggested that such harmful effect could be counteracted by chemical treatment of the sewage, but where, as here, the health and the lives of more than half a million people are involved, we think no risk should be taken, and we feel impelled to deny appellee's contention in this respect. This view is sustained by the group of cases to which appellant has called our attention in which injunctive relief was denied on the ground that it was not absolutely essential to preserve the rights of the patentee, and would cause the infringer irreparable damage. In none of those cases were the facts as serious or might the results have been as dangerous [\*\*62] as in the case at bar. See *Thacher v. Mayor & City Council of Baltimore* (D.C.) 219 F. 909; *Landis Tool Company v. Ingle* (C.C.A.) 286 F. 5; *McCreery Engineering Company v. Massachusetts Fan Company* (C.C.) 180 F. 115; *Ballard v. City of Pittsburgh* (C.C.) 12 F. 783; *Blake v. Greenwood Cemetery*, 3 Fed. Cas. page 594, No. 1,497.

The decree is affirmed except as to the injunction, and as to it the decree is reversed. The costs of this appeal are adjudged one-fourth against appellee, and three-fourths against appellant, and the cause is remanded with instructions to dissolve the injunction, and for further proceedings not inconsistent with this opinion.