THE EVOLUTION OF THE SWIMMING POOL

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE
George H. Dye

1947

THESIS

The Evolution of The Swimming Pool

A Thesis Submitted to

The Faculty of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

By

George H. Dye

Candidate for the Degree of

Bachelor of Science

June 1947

DEDICATION

To those who pioneered the swimming pool and to those who are today furthering its progress this thesis is hereby dedicated.

INTRODUCTION

The purpose of this thesis is to provide for the engineer an historical background in swimming pools. Fredrick W. Luehring, author of Swimming Pool Standards states, "No comprehensive history of the swimming pool has been written--there is a need for such a study."

This paper, while its scope is limited by the lack of time, travel, and available literature, is still representative of a good deal of library research. The bibliographical compilation was carefully made to include all available material on the subject, yet only those books whose subject matter was incorporated in the text of this paper were included.

Although numerous books have been written on the subject, too often in recent years the pool designer has followed "cook book" procedures of design which is somewhat necessary due to rigid health and construction standards. There should be much time spent in examining the specific case of each pool so as to best obtain the most economical yet appealing structure. It is hoped that the material presented in this paper will aid the designer to incorporate the most satisfactory components and sidelines in his plans.

In general the material is arranged chronologically, but where it is necessary to trace paralleling developments of different pool types, each was followed through independently for reasons of continuity.

Perhaps the choice of the title should be explained. Since "evolution" implies any progress of formation or growth, I have used the word to cover the cycle-like pattern of swimming pool development and decline.

The conclusion of this paper summarizes and evaluates the factors which have most contributed to the development of the swimming pool and

it will be shown that there is more than the technical picture to consider in predicting future use and advances in the swimming pool.

A challenge is open to one who will someday use this paper as a framework for future enlargement on this subject.

THE ORIGIN OF THE BATH

The use of the Bath has existed in one form or another since the beginning of civilization, but in those earliest times man (as yet barbaric) made use of only the natural water supplies.

The employment of the warm bath originated at least five thousand years ago in the Far East. In recent years, excavations in India have unveiled a great hydropathic establishment at Mohenjo-daro (27), where, centered in one large quadrangle is a swimming bath 39' X 23' with flights of steps at either end. These pools contained platforms such as to accommodate those who found the water too deep. Although these baths were constructed for the use of the common people they were engineered against settlement and leakage. The lining of the pool was made of finely dressed brick set into mortar between three and four feet thick. Backing this was a one-inch thick course of bitumin and this was held in place by still another layer of burnt brick. Short cross walls between it and the verandah foundations counteracted any lateral pressure. This bath had a hypo-caustic system of heating by means of fires and subterranean channels. Well water was used and a covered drain drew off the stale water. To have reached such a pinnacle in that day we must acknowledge the presence of the "pool" in India many years before.

EGYPTIAN BATHS

About this same time in Egypt, the wealthy nobles had decorative pools inside their garden walls which were used also for bathing. About 2900 B. C. one of the early Pharohs had a lake-size pool built in the palace park for his diversion.

Wolf and Scheleyer also state that bathing pools existed in

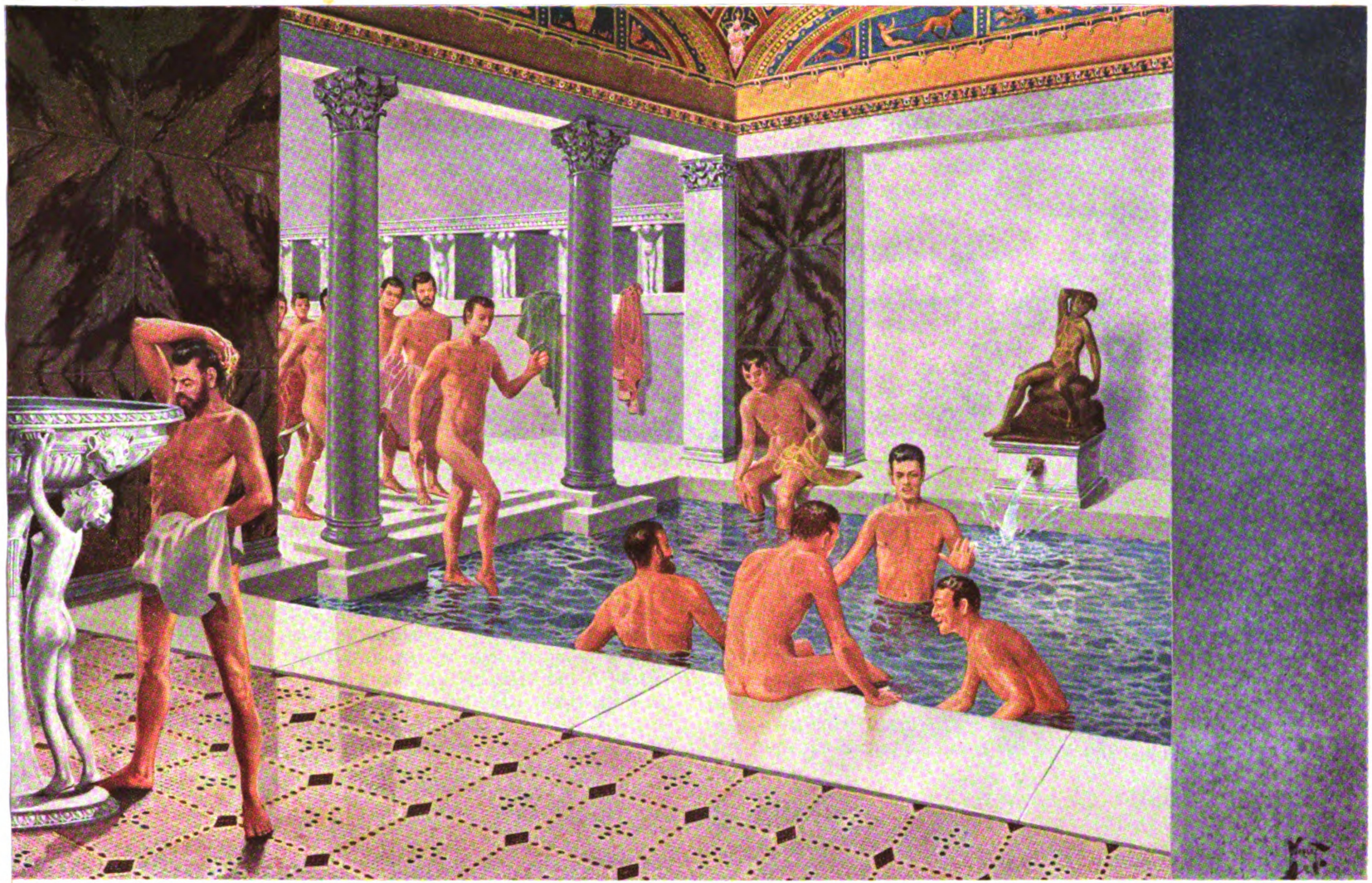
ancient Asia, Persia, Assyria and Palestine, and served chiefly as cleansing, ceremonial, and therapeutic media.

THE GREEKS ADOPT SWIMMING BATH

Swimming as such found its foothold in the early Greek civilization. It was given a high place in the Greek educational program. Plato states that the inability to swim was as detrimental as the inability to read. (16 Ch. 10) Among the Greeks the Lacedaimonians were the first according to Thricydides who adopted the custom from the Asiatics (2-p195). About five hundred B. C. some small cold plunges were built (27). These pools were in conjunction with the palistra or gymnasia. One hasn't far to look to see its modern day carry over. Within about two hundred years the pools became more elaborate probably due to the Roman influence. These pools were of various temperatures and were known as Kolymbethra. The pool at Olympia (the famous palistra) was small in comparison with one built some time later which measured 1.3 kilometers in circumference and about 10 meters in depth, which made it adequate for both swimming and diving (27). Perhaps the first natural warm water pool was built at Thermopylae by Herod Atticus.

THE ROMAN BATHS

More than those before, and for the most part more than those following, the Romans achieved an acme of swimming bath development. The Early Romans used to use the Tiber exclusively as their bathing resort, for as yet the vapor and hot baths were scarcely known to them. Rome being high in the hills, had difficulty in conveyance of water. It was over 400 years after the founding of Rome that water was brought by



Painting by H. M. Herget

"The Blue Translucent Flood in Its Snow-white Border, Whom Would It Not Tempt to Throw Off His Idle Garment and Plunge In?"—Statius, *Silvae*

and when it was found that certain channels carried undesirable water these channels would be diverted to irrigation uses only. The employment of settling basins reduced turbidity and strict legislation prohibited upstream contamination. Although the methods of flow measurement were crude and somewhat empirical, they nevertheless served as sufficient indices of flow quantities. Reference will be made to quantity of water a little later.

The Roman thermae used the heating system of the Indic bath, that is the Hypocaust system. In addition to this, care was taken to shelter the "pool" against the cold as much as possible, as is mentioned by Vitrius (26). The hypocaust system is worth explanation. Three bronze tanks were placed above the furnace, one tank each for hot, tepid, and cold baths. The tanks were so arranged that water might flow successively from cold to tepid to hot, thus economizing on heat. The vault-like chambers which held the basins were heated from a common furnace. Vitrius goes on to explain that the hanging floors were to be made as follows: "Pave the ground with eighteen-inch tiles build on an incline." This sloping aided in the spreading of the flame. On the pavement piers of eight-inch bricks were built at intervals of two feet to accomodate the two-foot tiles above. The piers made of clay worked up with hair were two feet high and supported the pavement. The vaulted ceilings were made of concrete or of timber lined with brick.

To further establish the enormous size of these baths we have only to cite the Baths of Caracalla in Rome. These baths included an area of more than twenty acres (29). "In the central buildings were halls so vast that thousands could wander through them at one time. Rooms with vaulted ceilings 70 feet above the floor, an enclosed swimming pool 200 feet long, and a steam room half as large as the Pantheon, hundreds

of marble statues, acres of mosaic flooring and thousands of square yards of costly marble veneering were adornments." (29) Yet, despite the size of this large center it was only one of seven in Rome, "Framing and setting off the geometric mosaics of the floor, marble steps lead down into a marble-lined pool filled waist-high with luke-warm water from a pipe concealed in a statue base behind a bronze lion's-head spout and was connected with the furnace boilers in the basement."

Sanitation was at a maximum considering the "Germ" was yet to be discovered. But if for no better reason than the pure asthetic appeal, the Romans accomplished almost ideal conditions. Perhaps the most important single item was the circulation system in the pools. Numerous inlets served to bring in the fresh water from the hills, while an overflow system guaranteed distribution of fresh water and served to break up the ever treacherous still surface of the pool. So much emphasis was placed on this system of circulation that daily consumption of water in Rome for baths alone reached 200,000,000 gallons per day (14). This figure is well over the amount used by the city of Lansing, Michigan in two weeks for all purposes. Strict compliance with pool regulations was also necessary. It was a definite preliminary for the bathers to go to an "unctuarian" where they were annointed with oils and covered with sand and then scraped thus cleansing themselves before entering the pool!

Some other interesting features of Roman baths and pools are furnished by Pliny (30-pp 207-210). "But the best dipped frigid heads, soused in, and swam sub-aqueous, a wonder to behold." This substantiates the fact that diving was carried on in the pools of that day despite the limited depth of 4 to 6 feet, an incomplete turbidity control of the water, and the accompanying darkness of the lead lining of the pool. Whatever the

Painting by H. M. Herget

"Where Languid Creeps the Warmth Around the Building and a Thin Steam Spreads Upward from the Furnaces Below"—Statius, *Silvae*

degree of diving, we are safe in assuming that no diving boards were used. Galleries of varying size were features of all swimming baths. These galleries ranged from a few rows of steps bordering the pool to the gigantic aquatic amphitheatre which could hold thousands. The pool was large enough to hold simulated sea battles with thousands of men and real ships of the time being used.

The Romans carried with them into their acquired territories the custom of the bath and the swimming pool. Among the nations so benefitted were Spain, France, Asia Minor, North Africa, Germany, and England.

THE ROMANS AND THE BATH

Investigating these pools in foreign territories of Rome is interesting as it shows the Roman influence but in most cases a contributing local influence of economy entering in. Perhaps the most orthodox territorial bath was built in Trier on the Moselle River. Modern Trier has a population of 88,000, which is but a fraction of the ancient German city (29-614). R. Carpenter and W. W. Hyde go on to describe the large bath located in "Rome beyond the Alps". "In Trier which was the residence of the first Christian emperor, Constantine, may be seen the most extensive Roman remains north of the Alps. The same heating system was used as in the Roman pools. The remnants of this bath have furnished a good deal of plumbing information. From the aqueducts which supplied the fresh water, minor conduits of stuccoed masonry, terra cotta pipes, and lead tubes and fittings took the water to the "pools". By the use of soft lead, the pipes could be easily cut, joined, and melted together. In this way, check and control valves were set in the pipes without necessity of threading the metal (29-614). The pipes

were suspended by hooks and were easily carried through the floors and inside the walls. One can not today frown on the plumbing used regardless of its appearance for it did most satisfactorily serve its purpose.

In England a Roman type swimming bath was constructed in the first century A. D. This bath was 82 feet long, 40 feet wide and lined with lead. Even today this bath is still water tight, and still receives water from the original spring source.

We find that in Cairo as late as 1880, a bath still in operation which might further the picture of the bathing procedure of the Roman bath (6). As one first entered the bath house he was led into a small carpeted room where he proceeded to undress. When this was done, he was led to a darkish hot room where he was seated on a marble bench. After becoming warm, the guide would lead the bather through a series of rooms. Each room was increasingly warmer than the one previous. Culminating this trip was a large steam-filled room with a central peristyle in the middle of which was a large steaming tank of water with steps running down into it. The walls of white marble contained beautiful inlays. The domed porticos of the peristyle were plastered and lighted by star-shaped openings in each dome.

A gutter was placed in the white marble rim of the bath. The bathers were laid down alongside of the pool and scrubbed vigorously with a horse-hair glove brush, then soaped, and scraped with wooden strips. The bather was then required to walk down the first step and dangle his feet in the nearly scalding water. He then proceeded to go down further into the pool, step by step, as his body became adjusted to the temperature, if such a thing was possible. Finally the attendant would take the initiative and pull the novice bather all the way in and duck him completely. After that, the bather might paddle about as long as he

could stand the heat. The process in leaving was no less prolonged than the entering process. The bather had to go through a series of hot to cold water baths before dressing.

THE BATH AND THE MIDDLE AGES

Some seven hundred years after the first Roman baths we find instead of a progress that a decadence set in. In 453 A. D. the "world" conquering Huns cut the Roman aqueducts. This left Rome without an economical water source. In their attempt to save water, the Romans cut down the rate of turnover in pools and were less particular in the purity of water used. (14) With this lessened water supply and a less prosperous government to meet the necessary repairs, the pools in Rome degenerated and became places of infection. So ended the glorious institution of a great empire.

Although there is very little information on the use of the swimming bath for the next thousand years there is much to observe in solving the problem of the lack of development in the middle ages. "In the middle ages there was a retrogression, for the spirit of ascetism did not foster ablutions." (13) The Crusaders took exception to this and borrowing the idea more from the Orient rather than from the Romans were instrumental in the spreading of the bath throughout Europe, though by this time in a very disguised form. From this point on, the bath was as big a social hot potato as taxation might be a political hot potato today. Physicians, clergymen and public officials would go first hot and then cold on the institution. In fifteenth century Denmark, bathing was practically unheard of, yet less than 100 years later the Scandinavians considered baths as indispensible. In St. Foix's "Historical Essays on Paris" we find that the mixed nobility were taking baths before each meal.

The attempt to bring back the pool in these days was licked before it could get started by two chief causes. First the failure to use a circulating system of fresh water and second, there was too much a heating problem. Both of these show the lack of public funds for in Rome the fee of one cent per bather hardly defrayed the large costs. As might be concluded, the pools became infection centers and were frequently traced as focii of small pox epidemics. This all combined to give the progress of the "swimming pool" another setback. The suppression of baths carried through most of France, Germany, and Denmark.

This was all the forerunner of an age of filth, for when Parisians, for example, gave up public bathing they also gave it up at home. At the time of Louis XIV, both the poor and rich classes alike were objects of filth. A book published in 1667 A. D. urged children not to use water and a learned treatise on the subject advised against bathing (2). In the reign of Queen Elizabeth a gossip sheet of the day stated "The Queen hath built herself a bath where she doth bathe herself once a month."

The baths that finally did return to Europe were so hybrid and contrary to any orthodox baths that they were perhaps called baths only for lack of another name. [A night club would be about the best modern equivalent of what sprang up in Germany and France.] The Romans who were quite modest in their bathing must have turned in their graves at the prospect of the baths being open to women, for it was seldom in old Rome that father and son would bathe at the same time because of modesty.] C. M. Ingleby on a trip through France in 1865 shows the trend in development (3). The pool in Bains de Loe'che, according to his description, had a centralized pool in a large room. With everyone assembled in the room, a water show started with men dressed in strange costumes entering

the pool. The atmosphere was typically "mardi-gras" and a banquet was served all the bathers as they sat around the pool. Champagne flowed freely and the climax was reached with the merry-makers dancing in the water.

The first mention of the use of bathing suits appears in the description of this pool. Bathers wore brown woolen suits. Diving was carried on in this pool, but no information was found that can state whether it was designed for it or not.

We find some evidence of swimming pool regulations crude as they were. No smoking or spitting, and of all things, the discussion of religion was not permitted in the pool.

The Romans, although believing in the Therapeutic values of a bath, didn't emphasize this feature to a great extent. The pool around a hundred years ago, perhaps otherwise lacking an excuse for existence, became the prescribed treatment of various ailments: neuralgia, rheumatism, scorbutic, and cutaneous maladies. In Russia, Finland, and Germany the vapor bath was much in favor of the swimming bath. Economy and sanitation making them practical. No description of these baths is presented as they de-emphasized the pool in these baths when they included it at all. It is interesting to note this expedient form of bath might well have arisen from economy. Just as an interesting interjection, we find that Jerome Napoleon had about the most distorted of all ideas in swimming bath use. Fantastic as it might seem, he filled the "pool" with wine (28). He claimed it as an invigorating source. No argument will be made on this contention, but one might well question his allowing his servant to rebottle the wine, however.

THE DEVELOPMENT OF THE MODERN SWIMMING POOL

The selection of any particular year or of any particular pool as being the forerunner of the modern pool is quite arbitrary, for we find no uninterrupted progress in any pool dating back a hundred years.

Since the floating pool doesn't seem to have much ancestry we might call it the first new advance in swimming pools from days of the Romans until seventeen hundred A. D. Hence we see how the cycle of development returned to the use of natural waters for swimming, this time confined. Floating pools were a pontoon suspended and floated deep in the water. The sides were filled with orifices which permitted a crude but quite sound circulation system. About the first record of the existence of this type of pool was in Paris about 1736. Called the Bains Vigier of Chinese Baths, these baths were a floating, swimming, and bathing structure. We find that thirty to forty years later these pools had become quite elaborate. Two stories, galleries, windows, and bath chambers were to be found in these 1760 pools in the Seine River. There is record of a floating pool as long as a ship of the day, surrounded by two decks, and holding a hundred persons at a time. (31) France has not given up this type of pool, as is substantiated by record of their existence as late as 1936, on the Seine River. Improvements have modernized these old pools and most of them have been cut off from river flow and equipped with an independent recirculation system.

The use of the floating pool was wide-spread and the 18th century found this type of pool built in Germany, Austro-Hungary, Norway, Sweden, and Switzerland. London, not to be outdone by the countries on the continent built the most impressive of all the floating pools in 1875 on the banks of the Thames. This was an indoor structure of wrought

iron, wood, and glass (32). This pool contained a diving platform made of steel girders. The pool's dimensions were 135 feet long, 25 feet wide and from 3 feet deep at the shallow end, sloping to 7 feet deep in 90 feet and leveling off there for the remainder of the pool length. This pool had one distinct feature of heating the water. Filtration, aeration, mechanical pumps which provided a six-hour turnover, all contributed to make this pool spectacular for its day. The design of this pool placed much emphasis on illumination as is shown by the use of glass roofing and siding. Since heating costs would be too small to justify the operation for small winter trade, the pool was sometimes used as a skating rink in the winter, thus insuring economic stability. The most remarkable thing of all in this pool was that despite being located in the polluted Thames and with no sanitary water treatment, it did operate a long time without being a noticeable infectuous source. This shows how beneficial the mechanical filters and aeration can be in removal of bacteriological contamination.

POOL DEVELOPMENT IN THE UNITED STATES

As we might suspect, the floating swimming pool in the United States followed those in Europe and was influenced in design by the European pools. Philadelphia was the scene of the first floating pool in the United States. Baths appeared there on the Delaware and Schuylkill Rivers in the early 1800's. Evidence of another pool anchored at Wind Mill later referred to as Smith Island in 1816, was cited by Jackson (33). The public floating pool's first appearance in the United States was in Boston in 1866 (20). Known as Braman's Swimming Bath, it contained many dressing rooms. There was a pool for swimming plus a smaller tank for the private bather. This tank was set in an enclosed compartment to

insure privacy. These pools proved popular and in the next few years eleven had been constructed in Boston. New York soon took the lead and had built over two dozen of this type of pool by 1870. Nearly all the big cities on the east coast soon had built one or more floating pools.

The American version of the floating pool was put to many uses. Swimming, bathing, and swimming instruction kept the pools busy. These pools were not equipped to heat the water, consequently they were in operation only a few months of each year. Engineers began to cater to the people and soon pools could accomodate both sexes at the same time. They had formerly had either separate pools or had used separate bathing days. The wading pool idea had its origin about this time, for in some of the floating pools in New York two pools were built with one shallow enough to accomodate children.

THE BATH IN THE LAST 200 YEARS

Before going further in the story of the pool, it is necessary to go back and trace the parallelling development of the bath. With the innovation of the floating pool we find the first real attempt to isolate the "bath" and the swimming pool. The public bath was slow to relinquish the pool and it still hasn't entirely done so. The bath tub made its first appearance in the United States in Cincinatti in 1842 (12). The first bath tub was a lavish affair made of mahogany and lined with lead. But before the bath could get a foot-hold, legislation was passed to set back its progress. Philadelphia in 1843 passed an ordinance to prohibit bathing from November until March. Boston, two years later, declared bathing unlawful except when prescribed by a physician. Virginia held down the use of the bath by leveling a tax on each of three hundred dollars a year. In general the bath came to the United States as a private

institution and although it did receive a good many early set-backs, by 1860 had become part of the American home. The Europeans still clung to the public bath because of plumbing if nothing more. Financially the Europeans were forced to still a new idea. The bath was incorporated with a public laundry. An article published in the American Architect and Building News in 1883 gives this report of the 19th century baths in Europe, "One of the institutions found in European cities which would be desirable to transplant to New York and other American cities is the "baunderie" (combination public laundry and bath). In Geneva on the Rue du Rhone was built such a place in 1857 at a cost of $30,000." These baths stressed sanitation even though unaware of the germ theory through tub scrubbing, etc. The author of this article was obviously against baths in home as he goes on, "There are some bathing establishments in Paris which have no laundry connected with them--few homes in Paris have wash stands--fortunately for the health of the race."

There was a fine "baunderie" in London called St. George's Baths and Wash Houses. This bath ran on a small income of between four and eight cents for admission. So we see that even with the added feature of the laundry, the swimming bath of those times was not a profitable enterprize. By 1891 three pools located in London were accommodating 235,000 bathers per annum. These baths were the Paddington, the Queen's Road, and the Bayswater. There was some class or economic separation in these baths--first, second, and third class.

By 1880, the English had entirely discontinued the use of baths built during the Roman occupation. Those situated in a dark, cold cellar on Strand Lane in London still served a function in that tourists would buy souveneir vials of their water.

American writers not satisfied with the use of private home baths

in the United States took up the cry for public baths. American laboring classes were openly called the "Great Un-washed" as many of these laborers couldn't afford home bathing. The sponsors of this movement were aware of the economic drawbacks so they appealed to philanthropists to back the venture. All this was in the 1880's (5). In 1890 Cosmopolitan Magazine offered a two hundred dollar prize for the best design of a public bath for the poor (1). Architecture was stressed in most designs and included a laundry and a turkish bath in addition to the pool. At this time the pool was referred to as a "plunge." These proposed pools were to operate on a seven cents a day fee, and still the public was slow to take full advantage of them.

For the most part these early swimming baths were the fill and draw type. In New York City in 1915 the river became seriously contaminated and the numerous floating pools were converted to the fill and draw type.

THE SWIMMING SCHOOL

Before leaving the subject of the floating pools, it is interesting to account for their rapid development. More perhaps than any other influence, the advent of the swimming hastened this development. Not since the days of the Greeks and Romans had swimming been treated as an integral part of the physical educational program. Pools served many functions the least of which was swimming during the centuries from about 500 A. D. till about 1700 A. D. Again Europe set the pace. In fact, the European swimming pools were in existence nearly a century before they were introduced in America. Benjamin Franklin was a strong proponent of this type of school and in 1726 made an effort to establish a school in England (27). Later in the same century, swimming schools

sprang up along the Seine River in Paris. These schools were set up to teach almost exclusively and were not in conjunction with the existing pools. Some of these schools accommodated both sexes in their training facilities. Germany followed early in the nineteenth century by opening a number of schools for swimming, and found it beneficial in training her soldiers. Denmark, Holland, Russia and Sweden were soon to follow.

Denmark trained a staff of teachers to teach in her pools (20). By 1825 we find that pool design was changed to accommodate the swimmers' needs. P. H. Clias was the forerunner of this movement in Denmark. "Francis Lieber and Ralph Thomas say that Clias copied the entire chapter on swimming from an earlier treatise, "Uber das Schwimmen," published anonymously in 1817, but really written by General Von Pfuel, who should be credited with the description as follows (20): 'The depth of water in the place chosen for swimming should, if possible, be not less than eight feet, and selected in the clearest, calmest water possible.'-- is to enclose a sheet of water 100 paces in length, 25 in breadth, and of the requisite depth with floats and to erect thereon ranges of board, which may support the scaffolding and railing necessary to support the poles during the time of practice.'" Other improvements set forth at this time were as follows: partitions for dressing and as a wind and sun break, diving boards (--"every swimming school ought to have a leaping tower from which the swimmers may leap from different heights"), provision of an aquatic sports area. One can easily note the modification of these recommendations in today's pools as it was originally recommended that the diving tower should be no less than thirty feet high.

Lieber, in establishing the swimming schools in the United States used the healthful assets of swimming as his sales talk. In general, the schools in this country made use of existing floating structures and

although they lacked depth for diving instruction, their spread to several of the east coast cities.

Along with the floating pool came the river and beach pools. They were like the floating pools in that they made use of natural bodies of water, but were different in that the beach and river pools were structures with foundations and in general more permanently constructed. As their contemporary, the floating pools, they had openings in the walls to allow the river to furnish fresh water as it would. France claimed pools of this type as far back as 1780 (27). It was this type of pool that became the first municipal pool in Liverpool, England in 1791. This pool was first constructed for a private owner, however. Finding this type satisfactory, but clinging to the bath, Liverpool, within thirty years, had constructed a much larger structure incorporating not only two swimming pools, but also two private plunge baths. This river pool contained a means of heating the pool water, thus making it an all-year-round pool which was not common of most pools of that day. Perhaps the ultimate in the spread of these pools throughout Europe came in Vienna in 1876. Five large river pools were built along the Danube River which were capable of holding 1,270 persons at a time. This venture was a half-million-dollar one.

The river pool was in advance of the floating pool in America. In 1791, one was built on the banks of the Schuylkill River in Philadelphia. It was built in conjunction with the established Wigwam Baths. A privately controlled pool, it was complemented with bowling greens.

It is well to weigh all the advantages and disadvantages of both the floating pool and river pool construction. Their advantages were numerous and pronounced by their rapid growth. The economic factor was paramount for these pools were simple in design and low in construction

costs. They appeared especially appealing to communities whose water frontage was large because of free water. Pumping wasn't necessary, hence cutting operation costs. The disadvantages soon began to outweigh the advantages, however. First of all there generally was no provision made for heating in these two types of pools, therefore limiting their use to the summer months. Water frontage used by shipping companies made fresh water mooring of floating pools difficult, and besides, there was the constant danger of river traffic striking these pools. Most instrumental in the decline of these pools was the application of the findings of the germ theory. Pollution of streams and waterways increased because of population and industrial growth, and the largely wooden structures as they aged provided excellent conditions for the growth of microorganisms. It was found much harder to deal with the unpredictable sanitary conditions of the pool built in the water than in inland pools, hence the extinction of this new type of pool.

THE [illegible] TYPE

The third type of pool appearing in the 19th century was the land swimming pool. The British were the pioneers of this type after legislation called the British Baths and Wash House Act was passed in 1846. This law allowed the local authorities to sponsor baths and swimming pools. The increased interest in swimming was perhaps the most important of all. Swimming meets, diving contests, and water sports were on a large scale before pools were well under way in America. Such organizations as the Cambridge University Club and the Amateur Swimming Association of England were instrumental in bringing the pool inland. English pools were not pretentious structures during the 1800's and were sometimes used as auditoriums by placing temporary boarding over the pool (27). Pools

located on the Continent were less modest than those of the English. Germany and other continental countries used the sites of old Roman Thermae for their new pools.

The first evidence of the land pool in the United States was in Philadelphia in 1829. This pool and others to follow provided some swimming instruction. The use of showers was at first tried on a small scale in some of these pools but was soon discontinued (27).

SCHOOLS ADOPT THE LAND POOL

The biggest boon to land swimming pools came with their adoption in educational institutions. Girard College, Philadelphia was the first school to build a pool for its student body. This school provided at least four indoor pools in the basements of the dormitories, plus an outdoor pool. These pools dated back to 1848 and were used daily for over fifty years until proven unfit by the work in sanitation at the turn of the century.

The second school to use the pool was Gallandet College in Washington, D. C. in 1881, and served to influence Harvard, Princeton and Yale within the next twenty years to build pools for their students (27).

There seemed to be little agreement on the materials of construction in the early years of the land pools. From 1885 until 1904 we find that brick, stone, wood, brick with steel tank, brick and terra cotta, stone and concrete brick and marble, granatoid, and brick with concrete tank were all used in construction with little of any trend developing. Some still were not heating the pool water and were seasonal in operation. Dimensions made little sense; for example (27-5/6 x 77-5/6), (36 x 96) and (33 x 83½) were actually used in three pools of that time.

It wasn't until 1900 that the wood construction so popular during

the nineteenth century gave way to masonry and concrete construction.

SANITATION AND POOL GROWTH

Although Pasteur introduced his germ theory in 1860, it was twenty-five years before bacteriological studies were made on swimming pools and several years more before application of the findings was made, and pool design, operation, and administration were little affected until 1900. Studies such as those conducted by the German, Paginsky ("Uber die Basinbader Berlins") showed that certain diseases could be traced to the swimming pool. Sorge in 1899 and Priese in 1906 set up methods of testing and set indexes for measuring bacterial count.

Hundreds of books and pamphlets have been devoted to bacteriological investigations of pool water tracing the sources and relative importance of the infectious organisms, and hundreds more have been written prescribing the treatment methods. In striving for the most economical yet efficient means of killing bacteria some of the following methods have been tried.

To counteract acute infections of the upper respiratory tract, of the skin, and of the eye, R. M. Holloway recommended the use of a mild saline solution to be used in English pools. The more serious infections such as typhoid, dysentary, leptospherous, tonsilitis have been fought by miscellaneous kinds of treatments. Ozone, chlorine, silver, silver nitrate, ultra-violet rays are only a few of the tried methods.

Today the health standards set up by most states and by the U. S. Treasury Department control pretty much the sanitary conditions in the existing pools and the design of sanitary facilities in new pools. These standards were set up only after weighing over a period of years the evidence of numerous, often conflicting surveys. For example the am ut

of chlorine residual used in pool waters seems to be ever increasing. Perhaps the first reason for its presence was Dr. Wellman's experiments in the 1920's with sampling bottles including sodium thiosulphate. It was found that the chlorine had been continuing to act on the bacteria after sampling, thus producing an inaccurately low count, but when the sodium thiosulphate was added it stopped the germicidal action of the chlorine and gave an increase to the bacteria count. In general the E coli index has been used but much work has shown the test for streptococci is of great importance. The other reason for increased chlorine has been to serve as a safety factor against pool overloads. It was originally contended that chlorine was irritating to eyes when in excess of 4 p.p.m., but experiments have disproved this contention.

Other standards coming from sanitary research include specific water design, minimum turnover time of pool water, and rigid pool maintenance.

POOL OPERATING METHODS

The most important change in American pools has been the change from the fill and draw type pool to the recirculation type. The recirculation system, although more expensive at first, is more economical in the long run because of the huge savings in water. Although a few fill and draw type pools are still in existence, they are definitely outmoded for large swimming loads. Turbidity standards make it a requirement that the bottom of the pool may be seen by a person standing outside of the water. This standard enhanced the asthetic side of swimming and has served to protect the swimmer from being struck by divers while in the water. Modern pools have used the filter to reduce much of this, but since the algae growths in the pool also contribute to the turbidity a copper sulfate solution is employed to kill this. Piping systems must

so be designed as to (1) fill the pool, (2) circulate the water through the treatment equipment, (3) wash each filter individually, (4) discharge filtered water to the sewer, (5) operate the suction cleaner and discharge its effluent to the sewer, (6) empty the pool, (7) drain the entire system, (8) regulate the flow through individual inlets or groups of inlets and (9) chlorinate before filtration (63). Hundreds of design standards are available and should be checked before starting a design. Since it is not within the purpose of this text, we will not include all this easily accessible material.

The construction of late has been principally of reinforced concrete. The designer has been influenced by the depth requirements for diving, the volume of water per swimmer for sanitation, and the exacting lengths necessary for swimming events, yet they have shown some originality in their work. T-shaped pools such as were used by the Egyptians, oval pools that can be converted for swimming meets, wading pools to accommodate the children, and in general the most for the least expenditure has been the principle followed.

Pools of recent years provide interesting studies. Some time will be devoted here for a description of some of these pools. A pool 60' x 100' at Texas A. & M. College built in 1933 was designed with water economy in mind. The periphery overflow, instead of being wasted to the sewer, flows to a "surge tank" which is connected by a float control valve pump sump. The float control valve allows fresh make up water when the surge tank water level falls below the twelve inch depth (59). A heat exchanger with the showers and pool saved heating costs. The building was heated by thermostat-controlled gas-fired heaters with motor-driven blowers.

In designing the pool in the White House certain restricted conditions

had to be met. The specifications demanded that water temperature should not vary over ten degrees. A machinery room consisted of two levels. Three pumps serve individual duties. One pump circulates the water in the pool, another pumps serves to back wash filters and in the vacuum cleaning system, while a third pump (vertical) takes care of sump pit drainage (64).

A new swimming pool built in Milan, Italy in 1934 combines features to make it one of the world's most modern. It is a two pool set-up--one called the Olympic Pool and the other a non-swimmers and children's pool. The Olympic pool is 33.3 x 20 meters with depth varying from 2 to 4.5 meters. The small pool measures 20 x 10 meters with depth ranging from $\frac{1}{2}$ to $1\frac{1}{2}$ meters. Besides the tile lining such features were included as underwater lighting, diving platforms, colored tile markings for swimming lanes, and hand rails. A recirculation system was used, filters were employed, the treatment for bacteria consisted of chlorine with ammonia, plus aeration, and the heated water was completely changed every eight hours (58).

Both pools are housed in a building covering an area of 4,800 square meters, the central hall covering a space 60 x 40 meters. Interior walls are of finish in light green marble. Submerged search lights in the pool provide the lighting. The roof contains four large glass sections, two of which can be opened. Abundant showers and dressing rooms were built with inclusion of Turkish and Russian bath facilities. Three thousand seats are provided for the spectators. The building includes a large restaurant and for those who don't find the water wet enough, there are two elaborate cocktail bars provided.

Australia was soon to adopt the modern devices because her pools were largely salt water. In 1936 we find the Olympic Pool at North Sidney

incorporating a continuous recirculation system with eight hour turnover, filtration, and chlorination even though it uses salt water in the pool (47).

In 1941, the city of Montpelier, capitol of Vermont, whose population at the time was less than 8,000, completed a recreational field covering 25 acres. Included in this project was a large modern pool whose capacity is over a million gallons. The materials of construction are interesting to examine. The pool was built of asphaltic stabilized soil covered with a 2½-inch base of course asphaltic concrete, and a 3/4-inch sheet asphalt surface which was given a light surface treatment, sanded, and then sprayed with asphalt aluminum paint (41).

In 1933 Wilton Brigel gave his own recommendations on pools. He stated that only 15% to 25% of the pool area should be used for diving. His pet contention was that sand bottoms should be used in pools (61).

A unique engineering feat was accomplished successfully on a pool built in the early 30's in Port Monroe, Virginia. The construction embodied several interesting features, including the use of high silica cement and the intake arrangement by which sea water is collected from a series of well points after being filtered through the sand of the beach. Thirteen 1¼-inch well points were jetted into the beach in front of a new sea wall recently built along the shore. These connect to a header pipe which leads to a 4-inch double centrifugal pump which supplies 30,000 gallons per hour at a cost of eleven cents. This rate of flow provides a 7½-hour turnover. The overflow drains over through the sea wall to the beach. The water supply has proved excellent. Fresh water is added at about one gallon to every four of sea water to prevent eye stinging. No filtration or chlorination is necessary. Every 48 hours, 5 pounds of copper sulphate are place in a perforated can in front of one of the inlets to eliminate algae growth. High silicate cement was

selected because of its high resistance to corrosion as shown by laboratory tests (57).

There are many other interesting developments which will not be included here. The use of recently printed material will doubtlessly prove worthwhile to the designer in making the pool advance again as much as it has from the days when Archimedes jumped from a swimming bath shouting, "Eureka (I found it)!"

CONCLUSION

The swimming pool or its ancestor the bath has had a prominent role in the social life of countries in direct proportion to their economic and social advancement.

Of the technical advances made, none was more important than the discovery of the germ theory of disease and the subsequent research in sanitation which has today provided a number of standards which guarantee the modern day swimmer the safety from infection which he desires and demands.

From the earliest pools, economy has played an important role. The totalitarian regimes of the Romans and Indians with huge governmental backing were able to foster large projects, but as was shown when Rome was defeated and lost her economical water supply through the destruction of her aqueducts, the enormous system of baths became insolvent, and the forced economical use of water caused the downfall of Roman Pools. The incorporation of several social facilities such as bars, restaurants, dance halls, playgrounds, and golf courses all tend to mutually keep each other solvent. Modern pools still are public for the most part due to low margins of profit. Steps have been taken to minimize operating costs with such innovations as the recirculating system, the heat exchange

and the use of economical water sources, but much must still be done to insure the spread of the pool to private owners of moderate income. According to James A. Garrison in 1958, a swimming pool whose dimensions are 40 feet by 60 feet can be built for $3,000 under the index of that year. This figure is influenced by soil, climate, drainage, water supply, labor, and material prices.

BIBLIOGRAPHY

1. Walker, John Brisben - "Public Baths for the Poor" - Cosmopolitan Magazine (1890)
2. Lameau, M. Corbel - "Ancient Baths" - Chambers Journal (1846 - Page 195) - Traite Complit des Bains.
3. "The Social Bath" - Once A Week (September, 1865)
4. "Baths and Baunderies" - American Architect and Building News (February 24, 1883)
5. "Baths for the People" - American Architect and Building News (November 2, 1880)
6. "Hot Baths of Ancient Rome" - American Architect and Building News (March, 1889)
7. Doan, Titus Munson, M.D. - "Cold Baths and Abuse of Them" - Chandlers (1887)
8. "A German Bath" - Littells Living Age (January 27, 1877)
9. "Bathing at Home and Abroad" - Littells Living Age (November, 1863)
10. McPherson, John - Baths of Great Britain
11. McPherson, John - The Baths and Wells of Europe
12. "The Evolution of the Bath" - Literary Digest (June 19, 1926)
13. "Bathing Through the Ages" - The American Mercury (September, 1928)
14. "The Roman Way of Cleaning Swimming Pools" - Literary Digest (May, 1933)
15. Allsop, Robert Owen - Public Baths and Wash-Houses
16. Burgess, George - The Works of Plato (Vol. 5 - pp 78-120) London: Henry G. Bohn - 1852
17. "The Philosophy of the Bath" - Pliny's Letters - London: Moffat and Company - 1848 XIV 465 pp
18. Encyclopedia Britannica, Eleventh Edition, Vol. III, P.514 - Cambridge, England - 1910

19. Erman, Adolph - Life in Ancient Egypt - New York: Macmillan and Company - 1894 XII - 570 pp

20. "Public Baths in the United States" - United States Bureau of Labor, Bulletin No. 54 (September, 1904)

21. "Up to Date Floating Baths" - American School Board Journal (Vol. 84 - No. 4 - p. 65 - February, 1932)

22. Frisii, Andreae - De Arte Gymnatica - Mercurialis Hieronymi, Amstelodami (1672 - 387 - 41pp)

23. Peet, Eric T. and Cooley, Leonard C. - The City of Akhenaton - Part I, Boston: The Egyptian Exploration Society (1923)

24. Smith, W. A. - Dictionary of Greek and Roman Antiquities - Third Edition London: John Murray (1901)

25. Heineman, William - "The Stratagems and the Aqueducts of Rome" - Frontinus (1925) London. New York: G. P. Putnam's Sons

26. Spencer, Frank - Witruvius On Architecture (1936 - Vol. I, II) London: William Heineman, Ltd. New York: G. P. Putnam's Sons

27. Luehring, Frederick J. - Swimming Pool Standards (1939) New York: A. S. Barnes Company

28. Perkins, Mary Mendell - "The Marble Bath of Herculaneum" - Art and Archaeology (July, 1921)

29. Carpenter, Rhys and Vermeule, C. W. - "Ancient Rome Brought to Life" - National Geographic Magazine - Vol. 90, No. 5, pp 612-614 (November, 1946)

30. Overbeck, J. - Pompeii - Erster Band. Leipzig: Wilhelm Engelmann (1866 - 18 - 346pp)

31. Lester, William J. - "The Hygiene of the Swimming Pool" - Journal of the American Medical Association (Vol. 27, No. 25, pp 1982-1983)(Dec., 16, 1911)

32. Illustrated London News (July 19, 1879, pp59-60)

33. Jackson, J. - Encyclopaedia of Philadelphia, Vol. III, pp 633-916 Harrisburg: The National Historical Association (1932)

34. Marbeimer, Wallace A. - "Sanitation of Swimming Pools" - The Journal of Infectious Diseases, Vol. XV, pp 189-196 (July, 1914)

35. Wallman, H. I. - "Streptococcus is an Indicator of Swimming Pool Pollution" - American Journal of Public Health, Vol. 18, pp 771-774 (June, 1928)

36. Leiber, Francis - Encyclopedia Americana, Vol. 12, pp 88-91 - Philadelphia: Carey and Lea (1832)

37. Muedenehl, Paul H. - "The Economics of Pool Operation" - Municipal Sanitation, Vol. 4, No. 8, pp268-271 (August, 1933)

38. "The Swimming Bath At a New Technical College (Surv)" - Baths and Bath Engineering (1940, 7, 38) Summary of Current Literature (13, 139, June, 1940)

39. "Modern Swimming Pool Built at Balmoorlie W. A." - The Commonwealth Engineer (Vol. 26, No. 3, October 1, 1938, pp 111-112)

40. "Whipps Cross (Epping Forrest) Bathing Pool" - Baths and Bath Engineering (1937, 4, 219) Summary of Current Literature (Vol. 11, No. 6, June, 1938, p. 199)

41. Corry, W. F. - "Largest Municipal Pool in New England" - American City (56, 67-69, February, 1941)

42. Dienert, F. - "The Purification and Disinfection of Swimming Bath Water" - Chim. et Industr. (1937,38.1250.) Water Pollution Research, Summary of Current Literature,(Vol. II, No. 4, April, 1938, p. 122)

43. "Swimming Pool Operation" - Water Supply and Sewerage New,(Vol. 2, No. 8, August, 1938, pp 4-5)

44. "Temperature Control in Outdoor Pools" - The New Swimming Hole, Summer

Issue (p. 13, 1938)

45. Waase, L. O. - Chemical Questions Concerning the Preparation of Swimming Pool Water, Vom Wasser (12, 93, 110, 1937)

46. Garrison, James A. - "What Should a Pool Cost?" - In The Swim (Vol. 6, No. 3, March, 1938)

47. "Swimming Bath Water Purification. Practice in Australia" - Munic Engineering Sanitarium Record (1936, Vol. 8, p. 684) Summary taken from Dept. Scient. and Indust. Res. Summary of Current Literature (1937, Vol. 10, 121) Bulletin of Hygiene, (Vol. 12, No. 7, July, 1937, p. 508)

48. Auld, B. V. - "Purifying Liquids; Swimming Baths" - Ill. Off. J. Pat. London (1936) Summary of Current Literature (Vol. 10, No. 4, p. 121, April, 1937)

49. Lomax, E. - "Modern Swimming Pool Design" - Baths and Bath Engineering (1936, 3, 61, 99 and 127) Summary of Current Literature,(Vol. 10, No. 6, June 1937, p. 194)

50. "Circulation of Water in Bathing Pools" - Baths and Bath Engineering (1936, 3, 138) Summary of Current Literature, (Vol. 10, No. 6, June, 1937, p. 194)

51. "Chesterfield Open-Air Swimming Bath" - Bath and Bath Engineering (1936, 3, 140) Summary of Current Literature,(Vol. 10, No. 6, June, 1937, p. 194)

52. Wallman, W. L. - "A Bacteriological Survey of a Swimming Pool Treated With Silver" - Journal of Bacteriology (1937, 33, 89)

53. Ellis, E. V. - "The 'Biofilter System' Applied to Swimming Pool Water Purification" - Baths and Bath Engineering (1936, 3, 246 and 264)

54. Russel, J. - "Filtering and Cleansing Apparatus for Swimming Baths" -

Journal of the Royal Army Medical Corps (Vol. 68, No. 3, March, 1937, pp. 182-184)

55. McCormick, W. J. - "Public Health Aspects of Wading Pools for Children" - Canadian Public Health Journal (Vol. 26, No. 1, January, 1935, pp. 26-32)

56. Amelung, W. - "Bromine Treatment of Swimming Bath Water" - Tech. Gemeinde. (Vol. 39, 1936, p. 56) Summary of Current Literature, (Vol. 9, No. 8, August, 1936, p. 263)

57. Cochran, W. W. - "Well Points Supply Sea Water For Swimming Pool" - Engineering News Record (Vol. 113, No. 23, December 6, 1944, p. 775)

58. Smith, Talbot, U. S. Consul G. - "Europe's Most Modern Indoor Swimming Pool" - Voluntary Reports to U. S. Department of State. Four typed pages (April 27, 1934)

59. Forsyth, James W. and Keller, F. J. A. - "Modern Mechanical Layout For a Swimming Pool" - Engineering News-Record (Vol. 111, No. 18, November 2, 1933, pp. 535-536)

60. "Swimming Bath Water Purification" - Water and Water Engineering (Vol. 35, No. 414, March 31, 1933, pp. 157-160)

61. Spiegel, Milton - "Developing Natural Swimming Pools" - American City (Vol. 48, No. 4, April, 1933, pp. 71-73)

62. "Concrete Swimming Pools" - Booklet of the Portland Cement Association (1937)

63. "Swimming Pools, Minimum Standards of Design" - Engineering Bulletin No. 17, Michigan Department of Health (Nov., 1940)

64. Brandt, Ernst W., Jr. - "Mechanical Equipment in the White House Pool" - Heating and Ventilating (Vol. 30, No. 9, September, 1933, pp. 24-27)

[redacted]

Aug 9 '48

207