lished about twenty years ago, a construction showing 27 per cent. of the total metal in the latticing recommended. Will it be believed, in view of all this, that at Quebec barely 2 per cent of the material is in the latticing and 98 per cent. in the longitudinal slabs. But such is the case, as shown by fully dimensioned details published in "Engineering." How this amazing departure from previous practice came about, and on what grounds it was thought to be justified we know not. It is hardly conceivable that it was pure inadvertence or neglect, and yet, had the contractors made an experiment on a quarter, or even a twelfth full size model, surely they would have discovered the weakness. If they did not their experience would have been strangely different to mine in my models of twenty years ago. There was no excuse for omitting such an experiment. There were over one hundred compression elements of the same type and approximately the same size as A9L, and the Phoenix Company possess a testing machine of 1000 tons power, of which they years ago supplied me with photographs and particulars.

Again, as a further precaution, an organised system of extensometry should have been carried out. By extensometry is meant the accurate measurement of small changes of length, and this art has now been developed considerably, and many simple and effective devices are available for the purpose. On every important or typical part of the Quebec bridge I would have had points finely engraved, say 3 feet apart, and measure their distances to the ten thousandth part of an inch from time to time during construction. In this way a strict watch could be kept on the actual stress. This has been done over and over again by our railway engineers in Victoria, and I have repeatedly done it myself with the simplest and cheapest apparatus.

The moral of the awful Quebec disaster to me is this: Have plenty of experiments on models, and a liberal amount of extensometry. Thus, and thus only, can the bridge engineer pursue his course with safety and confidence, and I trust that this will be done in building the new Quebec bridge that will doubtless replace that so lamentably wrecked.

NOTES ON MODERN BUILDING CONSTRUCTION.

By Major J. Monash.

For some time past the question of a revision of the Building Regulations of this metropolis has received attention, and municipal bodies have displayed activities in this direction. The excellent paper on "Building Regulations" presented recently to this Institute by Mr. Anketell Henderson has directed attention to many anomalies and incongruities in existing methods, and has made out a strong case for a thorough revision of our building laws. Such a revision, however, if confined merely to the correction of anomalies, would proceed but a very little way upon
progressive lines; and what has really become a crying need is the entire creation of a comprehensive set of ordinances permitting and regulating the introduction of methods of design and construction, which—when placed in contrast with existing forms—will constitute what may, without exaggeration, be described as a revolution in building practice. In many other countries such a revolution is an accomplished fact, but in Victoria we are only now undertaking the first steps. What appears to be needed, at the very outset, is a vigorous dissemination of some knowledge of the principles upon which these modern conceptions depend, not only among the lay community, but even among the ranks of the building professions. The architect, the engineer, and the builder have, to the author’s mind, a duty cast upon them of educating the community to a proper understanding and appreciation of, and a confidence in, up-to-date methods; and to this end it is necessary that the professions themselves should take up this subject vigorously, and, by means of papers and discussions arrive at a sound basis for future practice.

As a contribution to such a crusade, the author apprehends that a few notes upon this matter may, at the present juncture, be opportune to stimulate the interest of those members of the Institute in whose regular practice the problems and considerations involved do not happen to frequently occur. To prevent a misunderstanding by an application of these observations to a wider field than is at present contemplated, it is intended to deal almost exclusively with what may be broadly described as industrial buildings—comprising factories, workshops, warehouses, storehouses, granaries, together with certain classes of public buildings such as hospitals, residential chambers and the like. Broadly put, the field for the introduction of reforms is mainly that field where utility and economy are the dominating factors, and where aesthetic considerations take a minor place, or are entirely absent.

The principal requirements of an industrial building are stability, strength and fire protection. The functions of such a building are to provide for a minimum of cost, and for a minimum consumption of land in occupation, a maximum amount of internal accommodation, a maximum amount of light, protection of interior against the weather, a maximum of durability, complete rigidity under the vibrations of moving machinery or earth tremors, and a high degree of resistance against destruction by fire. In some cases, also, the support of the building upon indifferent or bad foundations is an element which seriously influences the design.

Omitting from our review buildings of a class which may be regarded in the light of temporary shells, of limited life, such as buildings wholly of wood, or walled and roofed with corrugated or sheet iron, the practice in this community has hitherto run largely upon the following lines:—External and division walls of stone or brick set in lime, or more rarely in cement-mortar,
resting upon continuous foundations of lime or cement concrete; interior supports being columns either of wood or bare cast iron, or bare steel staunchions; floor supports partly of wooden or iron or steel girders, loosely resting upon the walls, with or without the interposition of stone bearings; wooden floor joists resting quite loosely upon the girders, wooden flooring boards, wooden or lath and plaster ceilings, framed wooden hip roofs—in some cases of long spans having iron principals—wooden purlins, and corrugated iron roof coverings. In rarer cases the floor systems have been intended as, and are in a small degree, fire-resisting, consisting of coke breeze concrete jack-arches, resting upon exposed corrugated sheet iron, carried by exposed steel or iron girders, the ceilings being supported by wooden furring; the use of tie rods to resist the arch thrusts in this latter form being very much more the exception than the rule.

It will be observed that the underlying principle of any design on these lines is the congregation of a very large number of separate units of a number of totally different materials—widely different as regards their physical, thermal and chemical properties—the arrangement of these units in contact; with, broadly speaking, a minimum of actual attachment, dependence being had firstly and chiefly upon the stability resulting from mere mass and weight, and secondly upon the frictional contact of the units among each other.

It goes without saying that, in the light of actual experience, it has been possible to achieve on such lines, sound and useful buildings—with the very important reservation that they are at all times liable to total destruction by fire or earthquake—but the scientific question is whether those results have been achieved at a minimum expenditure of money and land values, having regard especially to their ultimate life and cost of maintenance.

Let us begin with a consideration of the external walls. The popular conception undoubtedly is that the external walls practically constitute the building, other organic parts, such as the floors, roofs, and internal supports being regarded rather as subsidiary appurtenances. This belief is fostered largely by the circumstance that hitherto the external walls and all things that appertain to them, such as their foundations, parapets and the like, have loomed most largely in the eye both by reason of their mass and bulk, and by reason of the high proportion of their cost compared with the total cost of the building. What, really, are the utilitarian functions of the external walls? They may be limited to three, and three only: Firstly, to aid in supporting the floors; secondly, to keep out the weather, and thirdly, to give stability to the whole building.

To deal first with the last function, a little consideration will show that scarcely any conceivable way of imparting a box-like rigidity to an entire building can be hit upon, which is less efficient and more wasteful, than the expedient of throwing a large mass of expensive material into the enclosing walls for the sole pur-
pose of giving them independent stability, that is to say, a stability which is deliberately intended to be not only independent of the bracing effect of the horizontal floor systems, but is actually intended as a means of imparting rigidity to the floor systems. If it were not for the realisation of the fact that it is only in quite modern times that the evolution and application of new materials for building purposes has opened up a new field of thought in regard to building design, one would be tempted to characterise past practice in this regard as having from the first been fundamentally erroneous. In the author's opinion, the time is now, however, ripe for saying that such a conception of design ought to be finally discarded. Instead, we have at our disposal the exact antithesis, viz., by creating within a building a series of rigid horizontal floor systems, incapable of distortion in their own plane, we may use the floor systems not only for the purpose of giving stability to the outer walls, but also for the full and exclusive exercise of the important function of giving stability to the building as a whole.

Let us reflect briefly upon the cumulative evil consequence of the older doctrine. If the walls constitute the chief element in the stability of the building they must be designed to be, at the very least, stable in themselves; in order to be stable, they must be massive, solid and heavy; they must, therefore, occupy a great deal of valuable space, and must also in a very material degree add to the total weight to be carried by the ground, which latter consideration again implies broader and deeper footings and foundations, and a further appreciable increase in wall bulk. The amount of concrete, masonry or brickwork in, for example, a five or six story warehouse wall with its footings, required for the sole purpose of giving to such a wall its necessary stability, and the amount of valuable space occupied by such a mass of bricks and mortar need to be only once fully worked out to be realized.

Next, dealing with the supporting functions of the wall, that is to say, the vertical loads to which it is subject, except in the rare case of a building so narrow that there are no internal columns, the proportion of the floor and roof loading delivered to the walls by means of the floor girders is never more than half, and often much less than half of the total weight of the entire contents of the building, the balance being carried to independent foundations by a system of internal columns. In any ordinary typical case, it is perfectly safe to say that of all the vertical loads which the outer wall has to support, the portion which is due to its own weight entirely overshadows the portion delivered to it by the floors which carry the entire contents of the building. As a consequence external walls in mass brickwork, concrete or masonry, have had to be designed, in the past, chiefly with regard to the function of carrying themselves, and likewise, extensive foundations have come into existence for the chief purpose of carrying these massive walls; neither walls nor foundations playing any material part in or bearing any real rela-
NOTES ON BUILDING CONSTRUCTION.

117

tion to the internal dimensions or the character of loading and occupation of the building as a whole.

Lastly, as regards the weather screen action of walls, it will be at once admitted that if a 6in. thickness of brickwork is sufficiently weather proof for a detached domestic building, or the exposed top story of a many-storied building, it is equally sufficient for every part of every building. Indeed it is hardly open to dispute that in our equable climate a thickness of 6 inches of any impervious non-combustible non-conducting material such as glazed brick, or terra cotta, or dense cement concrete is entirely ample as a weather curtain or a fire curtain in any part of the exterior surface of an industrial building.

The keynote, therefore, of the modern principle of building design is the entire abdution of the massive external walls, and all their attendant evils. Their three functions, as epitomised above, are allotted as follows: The rigidity and stability of the building as a whole is cared for by a series of rigid horizontal floor systems, rigidly connected at each floor level to the column systems; the vertical load-carrying functions are accurately apportioned to the column systems, comprising the usual internal columns, and a corresponding system of outer columns; and lastly the screen action is performed by a series of light curtains, filling up—where not required for light—the whole rectangular space formed by a pair of outer columns and a pair of horizontal wall girders. These curtains having no other work to do than to carry each its own weight, and to resist horizontal wind pressure upon its own area.

Such a procedure may best be described as a system of "frame building construction." A few of its advantages may be noted. The weight of the structure as a whole will, of course, be greatly lessened, implying not merely saving in cost, but also an immense reduction in the necessary foundation area. The percentage which the amount of useful internal capacity bears to the entire cubical capacity of the whole building is also, of course, much higher, which is a factor of great importance where land values are high. In a recent example in King William-street, Adelaide, the land has a frontage of 37ft.; a six-story building, with mass walls, would have required 23in. outer walls; the actual construction has 6in. curtain walls, giving a usable internal width of 36ft. in the latter, as against 33ft. in the former case, or a saving of 3ft. of frontage valued at over £1,200.

Again the definiteness of form accomplished by a precise arrangement of girders and columns permits of exact and certain stress computation throughout the whole building, so that the stress duty of every member, whether horizontal or vertical, can be precisely valued, and no broadcast allowances for uncertainties in this regard need to be made. This, naturally, leads directly to exact and economic proportioning of every part of the building, and makes also for a far greater degree of safety by eliminating the proverbial weak link in the chain.
The stability against total overturning is necessarily also far higher, where the plane of each floor and the plane of each wall possess a high degree of rigidity due to the joint strength which can be accomplished by the definite and positive attachment to each other of all the members in each of the three co-ordinate planes which meet at any joint.

The modern fore-runner of these newer thoughts on building design is, of course, the comparatively familiar American steel-frame building. Its earlier forms of expression have been qualified in several important respects by the experiences of numerous failures due in some cases to collapses—the result of the absence of a proper development of the rigid floor system—and in other cases to fire destruction—the result of the absence of a proper system of fire protection. Baltimore, San Francisco, and many minor instances, including our own conflagration of ten years ago have amply demonstrated the unsafety of unprotected steel work.

The author must be understood to be an advocate for frame building construction of any form only upon the clear basis of the complete fire-protection of all structural framework, and upon the complete rigidity of all floor design. Without occupying time in citing instances and authorities, the author believes that cement concrete of appropriate strength and texture, ranks first as a medium for protecting structural steel from the action of fire; next in order comes terra cotta if well bonded, and well keyed together; brickwork is objectionable as being too bulky; Practically speaking, cement concrete, by reason of its plastic manipulation, will doubtless find, in the end, the widest scope for this purpose.

It may therefore be said, broadly, that the choice of materials in the future for buildings of the type under discussion will be—

(a) Steel frame encased in concrete with reinforced concrete floors.

(b) Reinforced concrete throughout—constructed monolithically.

A few notes of warning are, however, to be sounded, in regard to some of the details of either construction. As to the steel frame system, the concrete casing must be executed so as to be an effective protection, likely to remain undisturbed during the rough treatment incidental to a fire. For this reason the mass concrete surrounding stanchions, pillars, and girders must be bound to the steel work either by a system of wiring or by expanded metal lathing or by a liberal use of wire netting. These expedients obviate the breaking off of large lumps of concrete, such as would permit of access of heat to the steel member. The steel should be free from oil, grease or paint, to permit of a high degree of adhesion between it and the surrounding concrete. Finally, the concrete must be regarded entirely
as a mere filling or casing material, performing no part in the stress functions of the member which it encases. The reason for this last observation is that the mass of steel present in such a composite member is necessarily so considerable, that the steel percentage is very many times greater than the highest percentage that it is practicable to regard, in the theory of reinforced concrete as scientifically understood.

As to reinforced concrete, the dangers lie in an altogether different direction, being—in fact—due to the failure of many people to recognise that both the theory and practice of reinforced concrete must continue to be for all time to come (as they have been in the past), matters requiring scientific study and practical experience as the first essential to sound practice. The hope that in the course of time royal roads to design would be found, and empiric rules formulated, which would enable practitioners, without study or effort, to design and dimension their work, seems doomed to failure.

The theory of the subject has now been standardised (so far as Germany and Austria are concerned) for over ten years, yet there is no sign of any escape from the position that either this field of work must be left to the professional expert and the specialist builder, or that the Engineer, Architect and Clerk of Works must be prepared to undertake the mathematical and practical study of the subject from its beginnings. It is, nevertheless, to be regretted that a more rapid development of what is undoubtedly a first rank system of building construction should be restrained by the hesitation of the public to delegate an entire branch of building construction to the hands of specialists. At the same time it is fair to say that the same observations apply with scarcely less force to the specialist in steel-frame design, and in only slightly lesser degree to the specialist in electrical and sanitary equipment of buildings,—and other subordinate branches of the art.

The practical consideration of the moment is that while the juncture has arrived when, in this community, the door should be opened to these new types of construction, the admission only of sound and safe practice in both fields should be jealously guarded. In the sphere of reinforced concrete, for example, there are to be found perfectly well-intentioned people who imagine that all that is necessary is to embed steel in a mass of concrete with but little regard either to its form, its position, its cross section, its surface area, its alignment, or its relationship to the gross bulk, while such minutiae as the physical properties of the steel used, or of the structure and composition of the concrete employed appear to them of little importance. A light-hearted disregard of some or many of these factors in design is found, upon examination, to be the whole explanation of a number of reported structural collapses in America, which occurred during the period before these forms of construction had become the subject of State or Municipal supervision and control.
The next modernising element in the design of Industrial Buildings, to which brief allusion will be made, is that of a modification to the limitation of cubical contents. Such limitations have been very usual in the Building Laws of all countries; but, as industry has grown in magnitude, as buildings have increased in size, as mechanical and electrical means of handling merchandise and produce have developed, such limitations have become more and more burdensome, and more and more restrictive of true development. For example, heretofore in Melbourne, no single building has been permitted to have a total capacity of more than 400,000 cubic feet. If greater capacity than this is needed, you must erect practically a second building or more, as may be required, because it is ordained that each such unit must be separated from its neighbours by vertical fire-proof division walls. Consider, for example, the case of a four story wool or grain warehouse, having a total height of 50 feet. The stipulation really means, in such a case, that the maximum permissible floor space undivided by cross walls is 8000 square feet, or say 100 feet by 80 feet! To what extent such a limitation interferes with conveyor and transporter machinery, and multiplies elevator equipment may be left to the imagination.

Now the restriction of cubical contents is founded wholly upon considerations of restricting fire to as small a compass as practicable. In principle, this aim is commendable, but its method of accomplishment has been of very doubtful value. In the opinion of the author, there is no comparison in real efficiency between the vertical, as contrasted with the horizontal, fire-break. The tendency is for fire to spread vertically, and not laterally, and instances of general conflagrations show abundantly that, where the only protection is a vertical division wall, the fire first guts the building in which it originates, and the embers and sparks falling upon its neighbours start the latter burning from the top downwards, and so on. Examples are equally numerous to show that effective horizontal fire-breaks confine a conflagration not only to the building first attacked, but often to the particular story in which the fire has started. The true solution appears therefore to be to so amend the regulations that a fire-resisting floor system of approved design shall be acceptable for the purposes of subdividing a large building, in lieu of, or at the very least, as an optional alternative to the vertical cross wall subdivision hitherto practised.

Precisely the same considerations point to the need for the adoption of a policy of insisting upon fire-proof roofs, especially in closely built-upon city areas. The fire-proof roof implies the flat roof; and a little consideration will show that the extra cost of such a construction is no serious burden upon the owner. A flat roof can, in many cases, be used for storage of non-combustible merchandise, and affords in effect an additional story; but in many cases the flat roof affords the greatest and most
desirable convenience as a yard, or garden space not otherwise attainable within city limits.

Structurally considered, the flat roof also constitutes the uppermost horizontal system, completing the box-like character of the modern building, and lending lateral support to the enclosing walls at their uppermost levels, that is to say, at the very place where they are most exposed to the action of high wind stresses, and most need such support.

It is high time that timber roof construction should be banished from the modern city. A visit to the roofs of many of our tall city buildings, and a view of the congregation of absolutely bare timberwork, or timberwork but thinly covered by slates, lead or thin sheet iron, in principals, rafters, purlins, trimmers, mansard or saw tooth light openings, vent shafts and the like makes one shudder to think what could happen from the falling embers of a large fire in a neighbouring block during the prevalence of a high wind.

A short reference must also be made to the question of the general rigidity of a building against vibration, whether from earth tremors or machinery. This is a phase of design in which building regulations (except perhaps in earthquake districts) are but little concerned. Nevertheless it is interesting to observe that the characteristics, which make for a type of building desirable in the general public interest, are the very ones which afford the best resistance against the destructive effect of vibration. The desiderata are, of course, rigidity of the integral parts of the building within themselves and inter se, also weight and mass in direct contact with the moving machinery.

In precisely the same sense that heavy outer walls and light loosely connected floors constitute a bad disposition of materials to accomplish general stability and fire-protection, so light outer walls and heavy floor systems realize the best possible disposition of materials to create great rigidity against vibration. It is really this feature of rigidity of the modern building which constitutes its most striking and distinguishing characteristic, as compared with older types. It is this feature which is so aptly implied in the expressive term of "Monolithic" construction.

In conclusion, the author hopes that these notes will aid in soliciting the attention of this Institute to the consideration of a question of supreme and immediate importance—the education of the community and its official representatives to a receptivity for new thoughts and new views in the realm of Building Construction—in the interests alike of economic advancement and of public safety.
was as much as 1000 tons. The figure was quite correct, as the quotations [read] from various published data would show.

In regard to Professor Kernot’s remarks on extensometer method, it was quite possible to measure to much less than the twenty thousandth of an inch at any individual observation, but he would like to know whether Professor Kernot had found it possible to remove the instrument and verify measurements at different portions of a structure and after periods of one or two months.

Professor Kernot said he proposed to apply the refined measures to the one-twentieth scale model. The corresponding figure on the actual work would be one thousandth of an inch. By having two fine lines engraved about 5 feet apart, they could measure to that degree of accuracy by means of a fine scale and a magnifying glass without any lever arrangement at all.

BUILDING CONSTRUCTION.

The President said they now had before them the paper by Major Monash on “Building Construction.” It was a question of immediate and local importance, some of the points of which were very forcefully illustrated by the great fire in the city during the previous week. While he was watching that fire, Major Monash’s remarks as to the importance of having horizontal rather than vertical firebreaks struck him as being illustrated. The walls of that building formed a great chimney out of which enormous masses of flames were belching, and a “snow storm” of fiery flakes was falling right up to the Trades Hall.

Mr. J. T. Noble Anderson said he had not read Major Monash’s paper very carefully, but he had noticed in glancing through the discussion on Mr. Henderson’s paper at a previous meeting, that the remark was made that architects had a tendency to make walls more fire-proof than floors. In recent buildings which he had seen, however, the floors were much more carefully fire-proofed than the walls. The type of building most used in large public stores was of strongly reinforced columns carrying extremely heavy reinforced floors and roofs, which were very elaborately made. The walls were mere curtain walls resting on reinforced concrete girders. That seemed to be a very favourite type at present in Great Britain. It pointed to the fact that builders were not so careful about the walls as of the floors and roofs.

Mr. Jas. Alex. Smith said in the light of the recent fire he would like some information. The paper stated there might be considerable spans of horizontal fire-break. In a case such as that, probably the floor span would be heated to a considerable extent, with consequent expansion. He would like to know
whether that expansion would in any way endanger the walls by bulging, or whether the expansion, or differences of coefficients of expansion, would be within the elastic limits of the structure and of its component elements, and might thus be treated as negligible.

Mr. T. W. Fowler said he regretted he was not able to be present at the last meeting when the paper was read. As he had not had time to study the paper carefully, he could not discuss it as he would like, but the style of construction which Major Monash was advocating was one which must commend itself very strongly. The system of reinforced concrete enabled the structure to be thoroughly tied both horizontally and vertically, in such a way that all the reinforced material could be thoroughly protected from contact with the flame. This would certainly commend itself to all, and he thought there could be very little doubt, in view of recent experiences, that Major Monash was thoroughly correct in advocating the horizontal as well as the vertical fire-break.

Major J. Monash, in reply, said he was glad of the opportunity of making a categorical reply. There had been nothing said in criticism, and only one question asked. As regarded that question, re the effect of heat on structural expansion, the question had to be treated in a double-barrelled way, the two alternative cases being where the outer walls were brick, or curtain walls. Taking the case of the brick wall, there was a decided difference between the floor system consisting of protected steel in any form, and the floor containing exposed steel. In the case of the exposed steel the rise of temperature must be very great, and consequently, there must be expansion to an extent which would entirely destroy the stability of external walls. But the moment they employed the system of steel protection by means of incombustible substances, such as concrete, the result was that during an ordinary conflagration the steel had not time to become sufficiently heated to cause any appreciable expansion. He knew of a case of a concrete floor building with brick walls, in which the whole structure remained intact. The building fell through being pulled down by the falling of an adjacent six story building. It was said that the concrete in the most seriously affected part of the building was not affected deeper than a quarter of an inch. That seemed to confirm the belief that no ordinary duration of high temperature was sufficient to impart to the steel enough heat to cause dangerous and destructive expansion.

He was aiming at getting rid of the stability wall altogether and treating it like a bridge or frame. Under varying conditions of temperature the whole building would then expand or contract together, and there would be no question in such a case of any demolition of walls, whatever there might be of local conditions or of dehydration of material. Most fire tests were made on a very small scale. They were going to work in the
most severe way to accomplish deliberate destruction; and those conditions did not prevail in actual practice.

He would like to put Mr. Fowler right on one point. He did not want the Institute to get the impression that his paper was an unreserved advocacy of reinforced concrete. It was an advocacy of framed structures, no matter what the material. They wanted to get away from the heavy stability walls.

He was bitterly disappointed that there had not been a fierce discussion on the subject. He would like to see a strong discussion, as there was evidence of a wide diversity of opinion. He held strong views on the matter, and was open to conviction that those views were wrong. On the other hand, he would like the opportunity of convincing others who did not agree with him. They all knew that the building regulations of the metropolis were in the melting pot, and the more they discussed the question and arrived at a proper basis for a future standard, the better for the community.

PAPER.

NOTES ON CURRENT ENGINEERING PROGRESS.

By Mr. J. T. Noble Anderson.

Looking back on recent wanderings extended over fifty thousand miles, and embracing three continents, it is no easy task to select a few notes to fill the very limited time that has been accorded. The temptation is to recite scenes calculated to strike the imagination—the magical crucibles of Niagara, the hot rush of work at Pittsburg, the immense, well-ordered modern workshops which the past few years have conjured into existence on historic sites at Sheffield and Manchester, the architectural growth of Continental European cities, or the sensational growth of Mexican engineering works. Leaving these, I can, however, most usefully fill the time with some brief outline of what is going on in my own line—hydraulic engineering. This is a branch on which I have laboured for a quarter of a century, and besides being myself so familiar with these subjects, they (water supply, sewerage, irrigation and works of hydraulic power) are very live subjects in this community. Incidentally, after sketching out what is doing in these branches, I purpose touching also on the subject which is always in the minds of most of us—namely, the standing and emoluments of our profession.

In the eighties, when I had graduated into the ranks of British hydraulic engineers, we took peculiar pride in the fact that our limited numbers contained all those great men who had so far
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