MECHANICAL ENGINEERING

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Colorado State Agricultural College.

Department of Mechanical Engineering

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Department of Mechanical Engineering

JAMES W. LAWRENCE, M. E.
Professor of Mechanical Engineering.

FRED N. LANGRIDGE, M. E.
Instructor in Mechanical Engineering.

ALBERT CAMMACK, B. M. E.
Instructor in Mechanical Engineering.

HIRAM PIERCE
Instructor in Carpentry.

WILLIAM ELZINGA
Instructor in Forge and Foundry Practice.

JAMES L. VEASEY
In Charge of Mechanical Engineering Buildings and Steam Plant.

FLORENCE M. ROLLER
Stenographer.

MECHANICAL ENGINEERING.

MECHANICAL ENGINEERING relates to the construction and use of machinery, such as steam engines, machine tools, etc.

It would be impossible to draw hard and fast lines between the various branches of engineering and no one has yet attempted to do so, and just how much should be included in a course in Mechanical Engineering is still largely a matter of the personal opinion of the one outlining the course.

The course as presented at The Colorado Agricultural College is such as is given at the best technical schools of the United States. The instruction is intended to be thorough and the equipment is of the very best, care being taken when obtaining apparatus that each piece shall be of the greatest usefulness for its purpose. Colorado is forging ahead magnificently along industrial lines, and with the development of the vast natural resources within her borders new industrial enterprises are springing up everywhere, while the older ones are becoming more firmly established. With this industrial growth comes a demand for men competent to solve the problems connected with such enterprises. Young men from this College are in many of these establishments, occupying positions of trust and responsibility.

This course prepares students for the profession of Mechanical Engineering. It teaches the general principles of engineering and unites theoretical work and practical re-search. Instruction is imparted by means of text-books, lectures, illustrations, and experiments in testing materials, machines and motors.

As the course in Mechanical Engineering is, in part, designed to enable the student to solve those problems relating to the generation and transmission of power and its application to machines, much of his time is spent in the drawing-room, workshops and experimental laboratory.

REQUIREMENTS FOR ADMISSION

Students are admitted to any year upon passing required examinations.

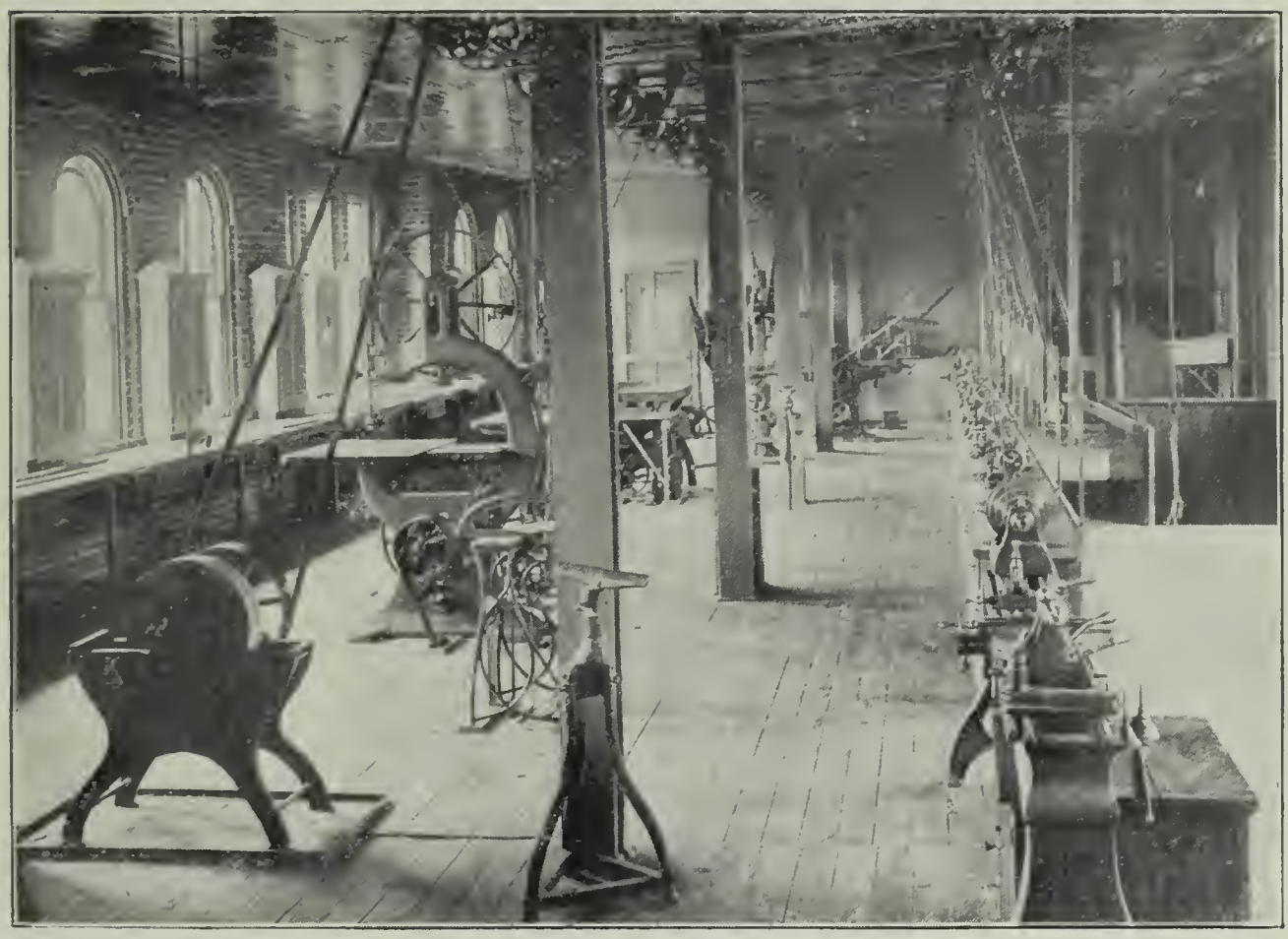
(1) FIRST SUB-FRESHMAN YEAR. Students presenting eighth grade diplomas, or certificates of standard excellence may be admitted without formal examinations, except such as come from towns having accredited high schools. The latter must pass an examination in arithmetic, grammar, reading, spelling, penmanship,

and United States history. Applicants for admission must be at least fifteen years of age.

(2) SECOND SUB-FRESHMAN YEAR. Those having finished the accredited high school ninth and tenth grades in a satisfactory manner will be admitted to the Second Sub-Freshman year without examination.

(3) FRESHMAN YEAR. Students are admitted to the Freshman year after thorough examinations taken in the subjects contained in the First and Second Sub-Freshman years, or upon the presentation of certificates of graduation from accredited high schools. Certificates from schools not accredited may be considered in arranging for entrance examinations. The following schools are accredited:

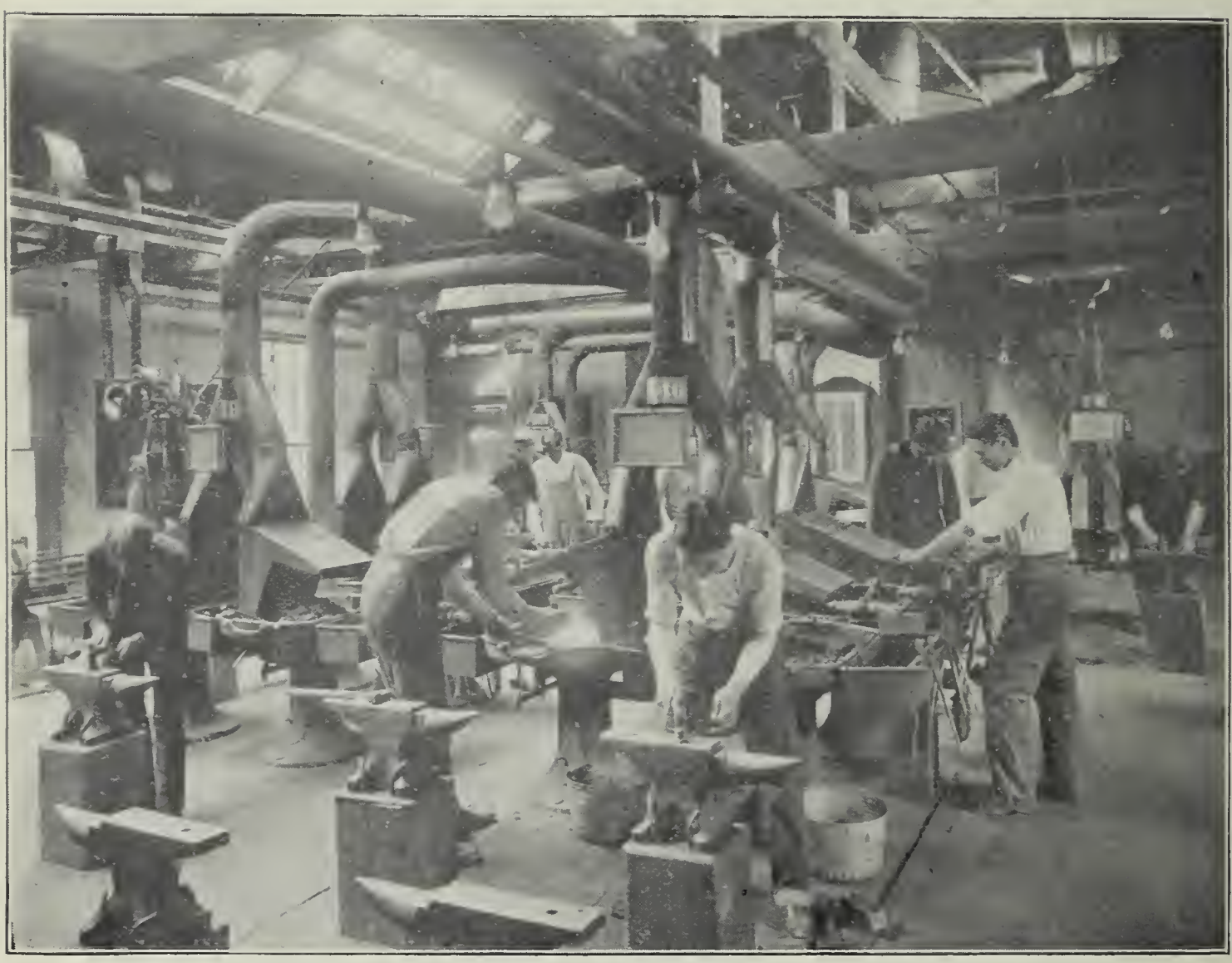
Aspen High School.
Boulder High School.
Canon City High School.
Carbondale High School.
Central City High School.
Cheyenne, Wyoming, High School.
Colorado Springs High School.
Cripple Creek High School.
Delta High School.
Denver High School, District No. 1.
Denver High School, District No. 2.
Denver Manual Training High School.
Douglass County High School (Castle Rock).
Durango High School.
Eaton High School.
Florence High School.
Fort Collins High School.
Fort Morgan High School.
Georgetown High School.
Golden High School.
Grand Junction High School.
Greeley High School.
Gunnison County High School.
Idaho Springs High School.
Lamar High School.
Las Animas High School.
Leadville High School.
Littleton High School.
Logan County High School (Sterling).
Longmont High School.
Loveland High School.
Manitou High School.



Wood Working Room Looking West.

Wood Working Room Looking East.

Mont Clair High School.
Monte Vista High School.
Montrose County High School (Montrose).
North Denver High School.
Pueblo High School, District No. 1.
Pueblo High School, District No. 20.
Rocky Ford High School.
Saguache County High School (Saguache).
Salida High School.
South Canon High School (Canon City).
South Denver High School.
Trinidad High School.
Telluride High School.
Union High School, No. 1, (La Junta).
Victor High School.
Wheat Ridge High School (Alcott).



Blacksmith Shop.

Candidates for advanced classes or work will be admitted by examination, or certified standing from schools having an equivalent grade of work, or both.

Applicants appearing late in the College year will be required

to pass, in addition to the entrance examination, a further examination in the work already passed over by the class they desire to enter.

The work of the Mechanical Engineering Course begins with the Freshman year.

First and Second Sub-Freshman Years

Leading to Freshman Year.

FIRST SUB-FRESHMAN YEAR

FALL TERM.

Algebra	5	P. M.—Freehand Drawing.... 5
Elementary Rhetoric	5	
Ancient History	5	

WINTER TERM.

Algebra	5	P. M.—Shop 10
Elementary Rhetoric	5	
½ Physiology	5	
½ Ancient History	5	

SPRING TERM.

Algebra	5	P. M.—Freehand Drawing.... 5
Elementary Rhetoric	5	
American Literature	5	

SECOND SUB-FRESHMAN YEAR

FALL TERM.

Geometry	5	P. M.—Physical Laboratory.. 10
Physics	5	
French	5	

WINTER TERM.

Geometry	5	P. M.—Shop 10
Elementary Botany	5	
French	5	

SPRING TERM.

Geometry	5	P. M.—Shop 10
Elementary Botany	5	
French	5	

Figures indicate hours per week.

MECHANICAL ENGINEERING

FRESHMAN YEAR

FALL TERM.

College Algebra 5	P. M.—Mechanical Drawing. 10
Rhetoric 5	Shop 10
Carpentry and Joinery..... 2	

WINTER TERM.

Trigonometry 5	
English Literature 5	P. M.—Shop (Bench Work
Mech'l Drawing (Lettering)..2	in Wood) 10
Rhetoric 3	

SPRING TERM.

Physics 5	P. M.—½ Physical Lab..... 10
Surveying 5	½ Surveying 10
College Algebra 5	

SOPHOMORE YEAR

FALL TERM.

Mechanics 5	
Analytics 5	
Machine Drawing 2	P. M.—Shop (Forge)..... 10
Descriptive Geometry 3	

WINTER TERM.

Differential Calculus 5	
Workshop Appliances 2	P. M.—Shop (Wood Turn-
Machine Drawing and Design..5	ing) 10
Descriptive Geometry 3	

SPRING TERM.

Integral Calculus 5	
Special Machines 5	P. M.—Shop (Pattern Mak-
Machine Design 5	ing) 10

JUNIOR YEAR

FALL TERM.

Principles of Mechanism 5	P. M.—Chemical Laboratory..6
Strength of Materials 5	Strength of Mater-
Chemistry 5	ials Laboratory 4

WINTER TERM.

Chemistry 5	
Machine Design 5	P. M.—Chemical Laboratory. 10
Steam Boilers 5	

SPRING TERM.

Steam Engine 5
Metallurgy 3
Hydraulics 5
Pumping Machinery 2
} P. M.—Shop (Foundry) 10

SENIOR YEAR

FALL TERM.

Gas and Oil Engines.....2
Steam Engine Design 3
Transmission of Power 3
Thermo-Dynamics 5
Compressed Air Machinery....2
} P. M.—Shop (Machine Rm.) 10

WINTER TERM.

Thermo-Dynamics 5
Heating and Ventilation.....3
Railway Mechanical Eng. 2
Contracts and Specifications...1
Seminar 1
Steam Engine Design 3
} P. M.—Shop (Machine Rm.) 10

SPRING TERM.

Thesis 3
Engineering Design 2
Electrical Machinery 3
Railway Mechanical Eng. 2
Constitution of U. S. 4
Seminar 1
} P. M.—Engineering Lab. ...10

Figures indicate hours per week.

THE COURSE OF STUDY

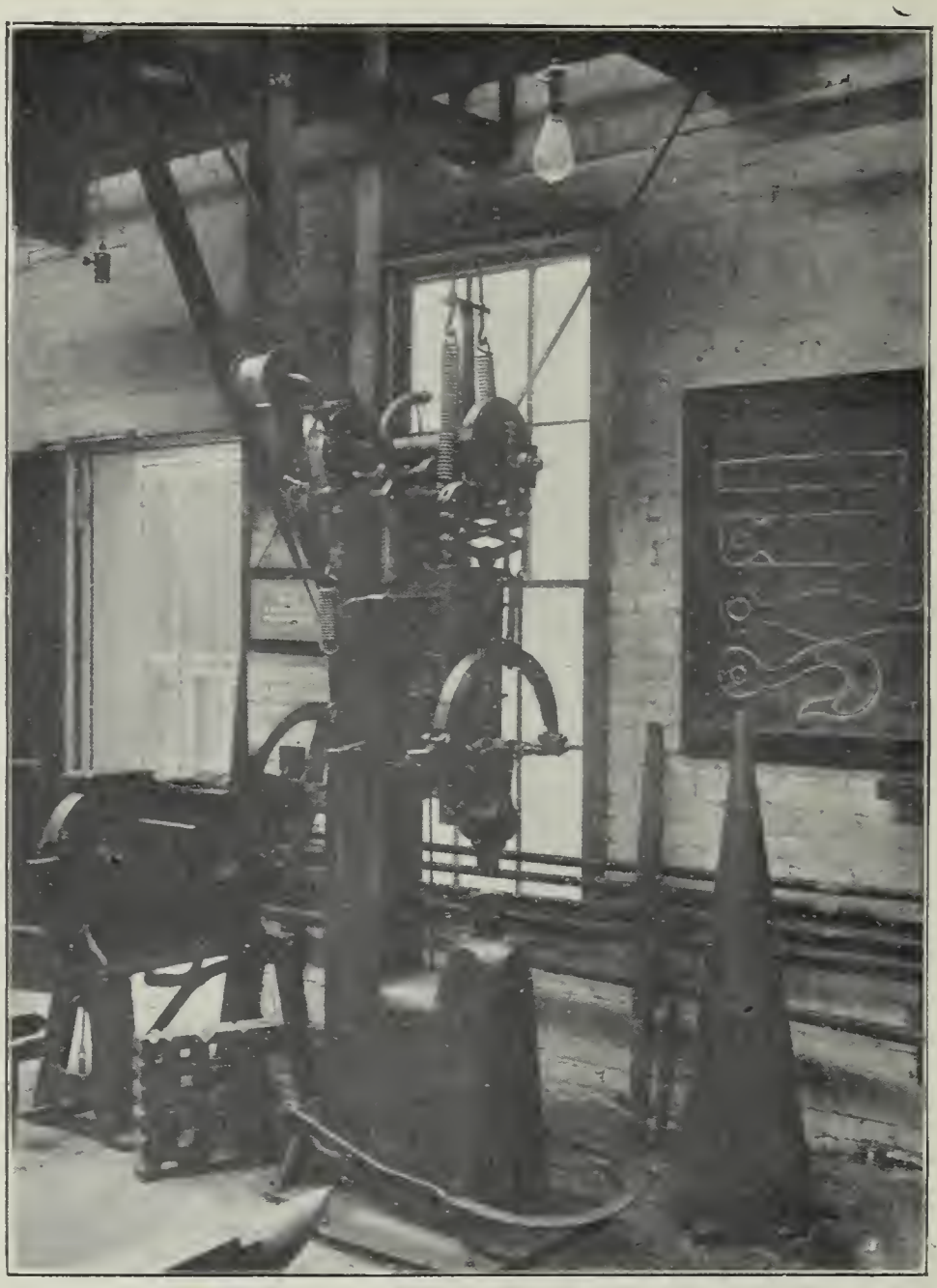
RHETORIC. It is designed in this work to train the student in the theory and practice of English Composition, and by the study of the fundamental principles of style, to aid him in an intelligent appreciation of literature. The students are given a thorough drill in the fundamental processes of English Composition, special attention being given to grammatical analysis, and the structure of sentences. The work is carried on daily throughout the Fall and Winter terms of the Freshman year.

LITERATURE

It is the object of this study to lead students by direct contact with the literary masterpieces to understand the art in literature,

and to develop their power of appreciating the strength and beauty of English writings.

In the Winter term of the Freshman year a course in literature is given arranged with special regard to the needs of technical students. The order of the development of the various forms of English poetry and prose is reviewed with a sufficient historical back-ground to explain the changes in literature, and to make the



A Corner in the Blacksmith Shop, Showing Power Shears and Power Hammer.

student generally intelligent as to the literary progress of English speaking peoples. The larger part of the term is devoted to the reading of such classics as will lead to an appreciation of the qualities which mark the work of good writers, both old and new. One aim of the course is to familiarize the student with the arrangement and practical use of the College library and to supply a working knowledge of its equipment which may guide his reading during the College course and later.

English Literature. The growth and development of literary art during the Seventeenth, Eighteenth and Nineteenth centuries will form the basis for work during the Fall and Winter terms of the Senior year. Much reading will be required and more recommended. The class work will consist of the study of several masterpieces from Milton and Tennyson, with written exercises on subjects suggested by the readings.

Library Reading. The College library is the laboratory of the literature department, and four hours per week of library reading is expected of each student in connection with all courses in History and Literature.

Foundry.

CONSTITUTIONAL HISTORY AND LAW

The study of the history of the Constitution of the United States and of the growth of free institutions, which that document so fitly emphasizes, is a prominent feature of the course, especially during the Senior year. Instruction is given concerning all the events and causes which led to the formation of the National Government

as it exists today, and the same traced to their historic sources. The workings of the Federal Government, together with its relations to the States, are also amply illustrated by frequent class lectures. Such information is due at the hands of every institution maintained by State or National aid as tending to better fit their graduates for the duties of citizenship, and for the responsibilities of a republican form of government which rest with especial weight upon those who have received their education free at the hands of the State and Nation.

In connection with the study of constitutional history, there is also instruction given in international law, which includes not only a concise investigation of the general principles and rules of this science, but a history of all the great diplomatic questions which have at different periods claimed the attention of the people of the United States, from the French alliance during the war of the Revolution to the conference at The Hague. This naturally comprises a consideration of the diplomacy which has led to all the vast acquisitions of territory which have extended the United States from the Atlantic to the Pacific.

Closely associated with this work are studies in political economy. Frequent lectures on the history and growth of the trans-Mississippi West are also given.

These studies, following a thorough course in history, cover in a comprehensive manner the various political sciences, and will be found of every-day practical advantage to all graduates when they shall have entered upon the real and active duties of life.

CHEMISTRY

CHEMISTRY. The prescribed course of study in this subject has been planned to include no more of the science than is advisable for a collegiate course, the object being to present the principles of the science and such facts as are necessary for a reasonable thorough understanding of these principles.

The means employed in giving instruction are recitations, lectures and laboratory practice. The aim is to give the student the benefit of the discipline of the recitation system, the illustration of the lecture and the inductive system of the laboratory. The object aimed at is wholly educational and is included in an acquaintance with the scope and character of the science, the necessity of a clear perception of facts and an exact statement of the same; also the importance of neatness and exactness. The latter are obtained by requiring all experiments to be done quantitatively, first requiring the student to calculate the result which should be obtained, and testing his work by the agreement of the actual results with the calculated one.

Laboratory practice is not begun until the student has received sufficient instruction in stoechiometric calculation, and the general properties of acids, bases and salts, to make him fully comprehend the simple problems given in illustration of the general principles of Chemistry.

Machine Room.

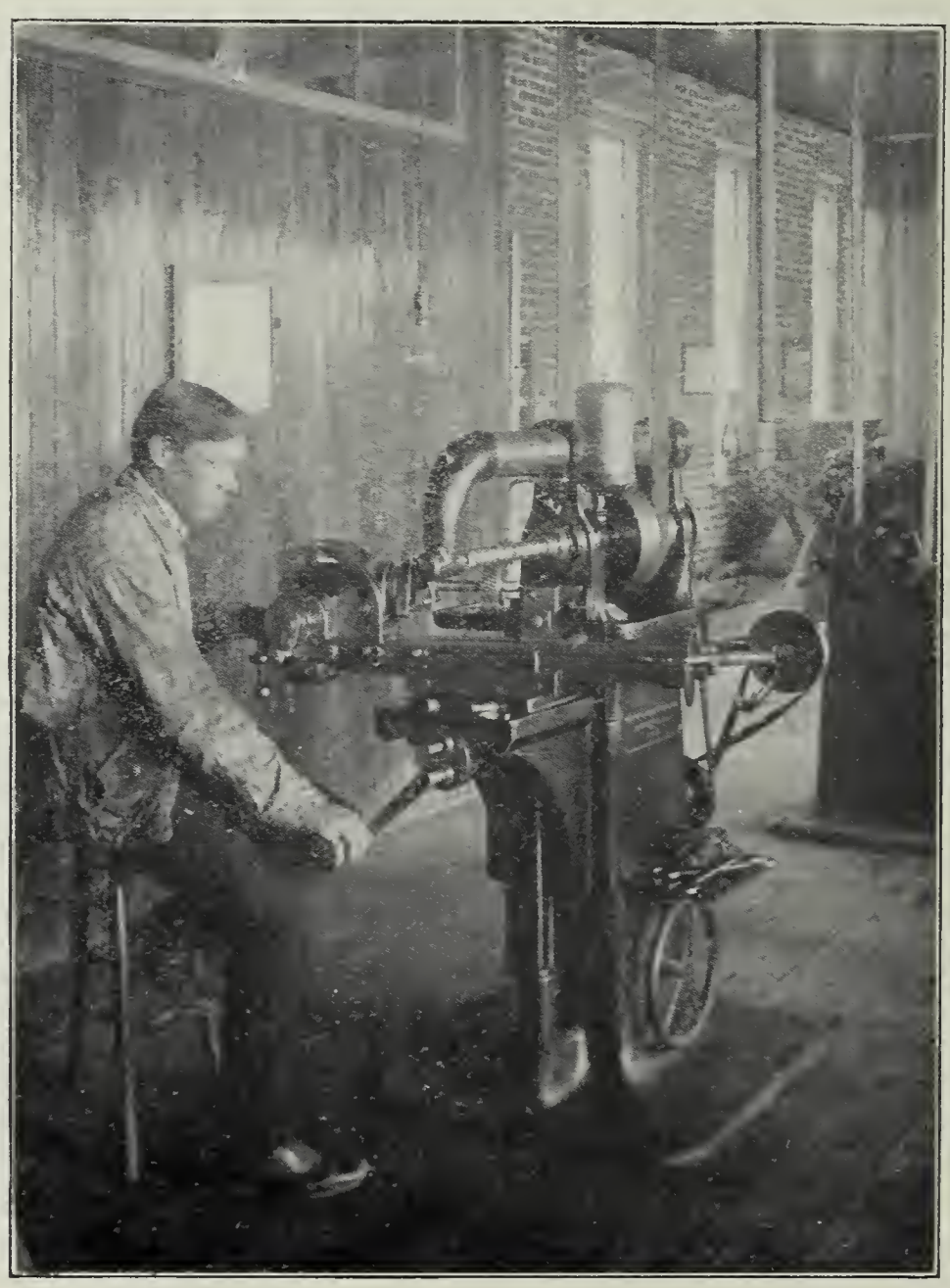
The instruction during the first term covers the general principles of Chemistry and the chemistry of the not-metals. The chemistry of the metals is given by lectures. Organic Chemistry is taken up during the second term and the fatty compounds completed.

MATHEMATICS

GENERAL STATEMENT. The course in Mathematics is full and complete. The different subjects are taken up in logical order as rapidly as the student has fitted himself for them.

FRESHMAN—College Algebra, two terms.
Plane Trigonometry, one term.

SOPHOMORE—Analytical Geometry, one term.
Differential Calculus, one term.
Intergral Calculus, one term.
Descriptive Geometry, two terms.



Student Cutting a Spiral Gear.

COLLEGE ALGEBRA. For two terms in the Freshman year the student deals with the principles of advanced algebra. The work begins with quadratic equations, and during the first term the student is expected to cover the entire subjects of quadratics, ratio and pro-

portion, variation, progressions, binominal theorem, and logarithms. During the second term the following subjects are taken up in order: Variables and limits, series, general properties of equations, derivatives, transformation and solution of equations of the third and higher degrees, and what time remains is given to choice, chance, and the graphical representation of functions, thus opening the way for Analytical Geometry.

Trigonometry. This subject is taken up in the Freshman year and during a term's work in it the student is made familiar with Plane and Spherical Trigonometry. He is given a clear idea of the trigonometrical concepts, shown their relations and given considerable practice in the practical application of this branch of Mathematics.

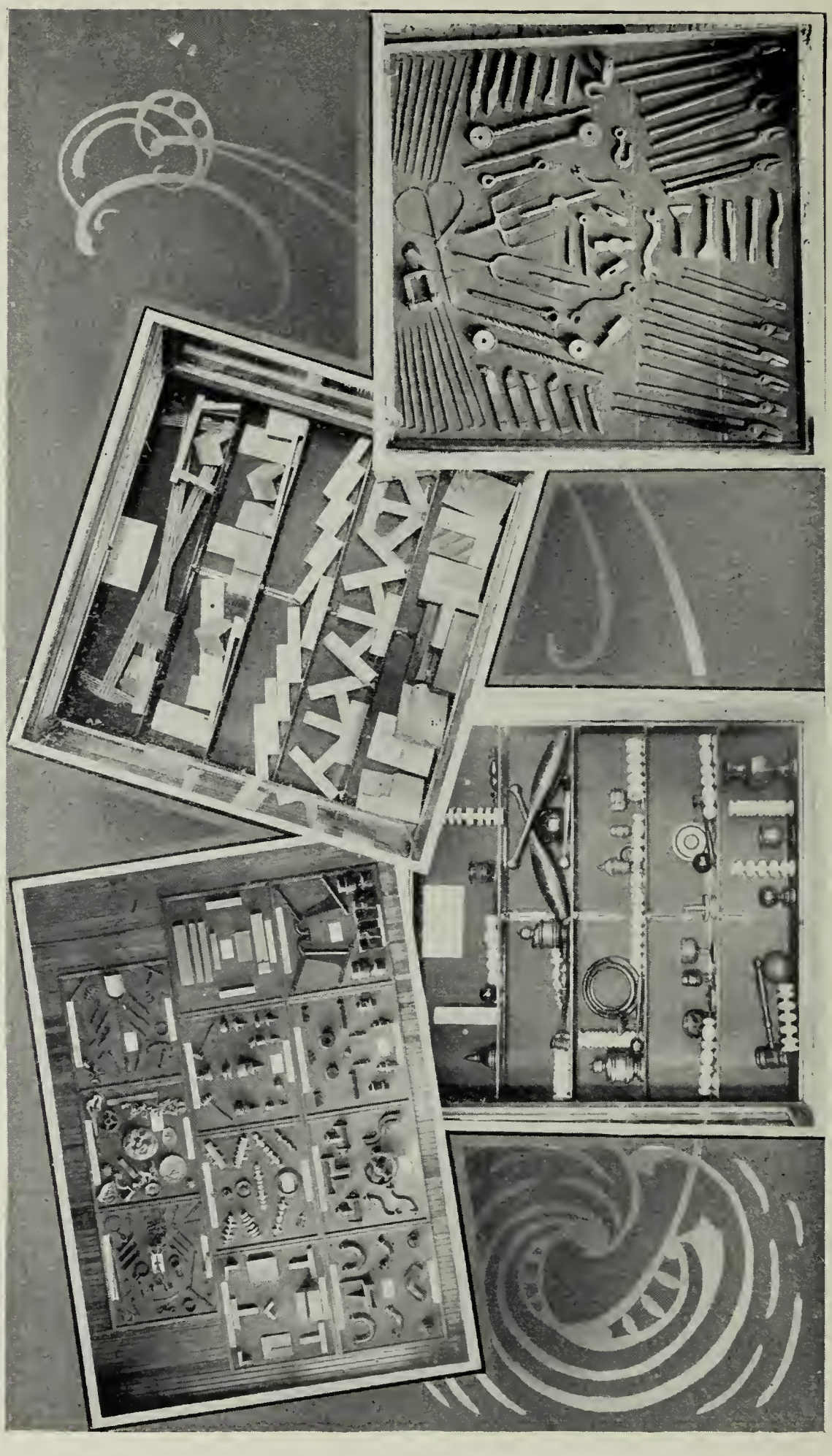
Analytical Geometry. This subject is taught during the first term of the Sophomore year. The student is made acquainted with the method of co-ordinates and the connection between algebraic forms. The fundamental properties of conic sections, loci of the second order, and higher plane curves are developed and as much more of the subject as time permits.

Calculus. The Winter and Spring terms of the Sophomore year are devoted to the study of the Differential and Integral Calculus. "Differential and Integral Calculus," by Granville, is the text-book used, and the subject is pursued as there given. The notation of limits is, however, made the logical basis upon which the subject is developed.

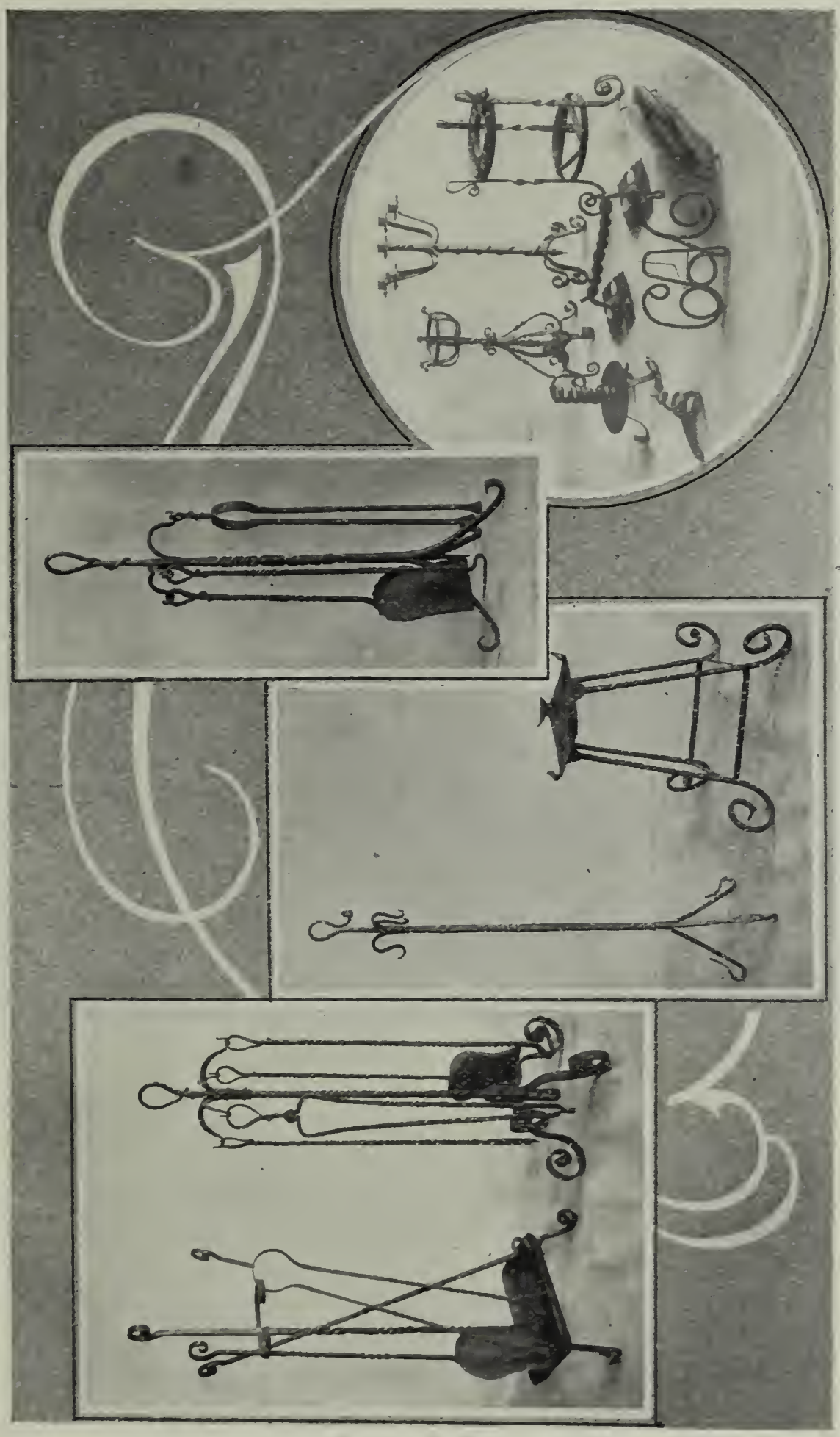
Descriptive Geometry. This subject is taught to the students for two terms during their Sophomore year. The principles of projection, intersection, development, etc., are discussed and illustrated by a great variety of problems, all of which are accurately worked out on the draughting board by each student.

The Mathematical department is provided with a set of Schroeder models from Darmstadt, and with models of warped surfaces, etc., for the purpose of illustration in the study of geometry. There is also a set of drawings for the use and study of curves and curve tracing.

Surveying. In the Freshman year land surveying and leveling, and the use of the compass and level as instruments of surveying are taught.



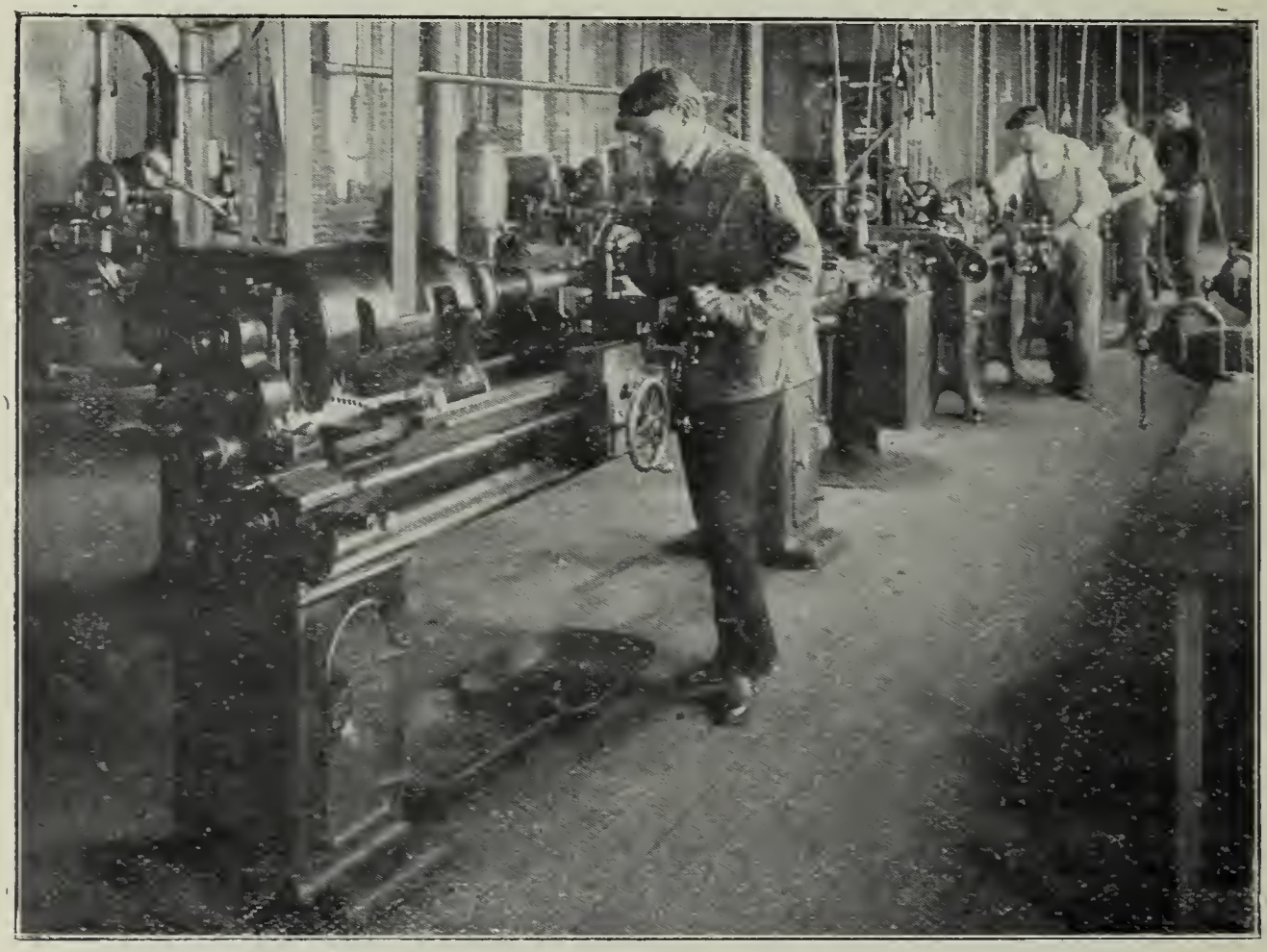
Samples of Students' Work from the Wood Working Room and Blacksmith Shop.



Samples of Work Made by Students in the Blacksmith Shop.

PHYSICS

The work in Physics has two main purposes in view: First. the thorough grounding in the mind of the student of those fundamental principles of the science that form so much of the foundation upon which all subsequent specialization in engineering rests; second, the testing for himself applications of these principles in the laboratory, thereby developing his reasoning faculty, quickening his powers of observation, giving skill in manipulation, and leading up to a high ideal of truth and honesty.



Students at Work in Machine Room.

The aim of the work in Applied Electricity is to give the advanced students that knowledge of the applications of electricity in their line of work that the increasing use of electricity in all industrial work demands.

General Physics. Spring Term. Lectures, Laboratory for Freshman Engineering students.

Mechanics. Fall Term. Sophomore Engineering students.

APPLIED ELECTRICITY

Spring Term, Lectures.

Seniors in Mechanical Engineering.

Lectures in the general theory of various types of generators

and motors, central station installations, power transmission, and electrically driven machinery.

The Physical Laboratory consists of office, lecture room, two rooms used for general laboratory work, a photometer room, apparatus room and shop. All rooms are well lighted by electricity.

The lecture room will accommodate thirty-five students. It is supplied with water, gas, direct and alternating electric currents, ample blackboard space, and with electric and solar projection lanterns. The demonstration apparatus has been especially selected for its value in teaching.

The general laboratory is equipped with micrometers, apparatus for determining coefficients of elasticity, for testing the strength of materials, acceleration apparatus, simple and reversible pendulums, chronograph, analytic and specific gravity balances; hydrometers, air pumps and accessories, thermometers, calorimeters, spectrometer, primary and secondary batteries with dynamo for charging the latter, standard resistances, a high resistance testing set, Crompton potentiometer and standard cells, standard tangent galvanometer, high sensibility galvanometers, quadrant electrometers, ohmmeters, ammeters, voltmeters, and wattmeters. Much of the equipment is new, all is in good order. This makes good quantitative work possible and permits a high order of accuracy to be insisted upon and maintained in all laboratory work.

The photometer room is provided with a Leeds' Station Photometer with all necessary appliances for measuring the candle power and efficiency of incandescent lamps. In the shop is a screw cutting lathe and a fairly good assortment of metal and wood working tools.

The students have access to a carefully selected reference library.

DRAWING

Free-hand copy and dictation; free-hand model and object drawing; light and shade; geometric problems, orthographic and isometric projections and projection of shadows, development and intersection of surfaces.

Free-hand drawing gives students facility in representing objects clearly upon paper. Free-hand exercises gradually lead up to making sketches of machines and parts of machines which are afterwards reproduced with instruments in the form of working drawings.

Students are taught how to make careful tracings from their drawings, and from these tracings how to make copies by the blue print process; the black print process is also taught. Considerable copying of machinery from good examples is required; there are in the drafting room for this purpose, working drawings from prominent manufacturers, and from the engineering department of the United States Navy.

The students receive careful instruction in lettering working drawings, so that in addition to being skillfully lettered, they shall be easily read and understood. Much time is spent at the drafting table, in designing machines. In some instances machines are built in the College shops from these designs.

MACHINE DESIGN is taken up for one term, and the students make designs for screws, bolts, nuts, gears, and complete machines, such as arbor presses, drill presses, lathes, engines, etc. In this connection the students make use of classroom notes, reference books, and notes and sketches made by themselves from their experimental work and their reading.

CARPENTRY AND JOINERY. The classroom work, by means of text-books and lectures, takes up the study of the cutting edge of various wood-working tools and machinery and the means of keeping them in good order; an explanation of the construction of each tool and its manner of acting on the materials, the methods of determining how to select materials best suited to different kinds of work; the manner of laying out the work, cutting speed of tools, etc.; the shrinkage and warping of woods and the different modes of sawing into lumber, and the various forms and uses of framing and other joints.

For the purpose of classroom illustration, the department possesses a good collection of models of the various joints used in timber work in building construction. The strength of various timber joints used in building construction is considered.

PATTERN-MAKING AND FOUNDRY WORK. The most advantageous forms of patterns are discussed with regard to the proper distribution of the metal and the best form for moulding in the foundry, the proper construction of core boxes and the various materials from which they may be made. Core mixtures, core-making, baking and finishing, receive careful consideration. The subject of core ovens is considered with reference to their form, construction and management, various types of cupola furnaces are discussed, methods of lining, introduction of the blast, the placing of tapping and slag holes, different forms of tuyeres.

FORGE WORK is taught by lectures on iron and steel, and especially with reference to their management in the fire and in the processes of tempering, hardening and annealing.

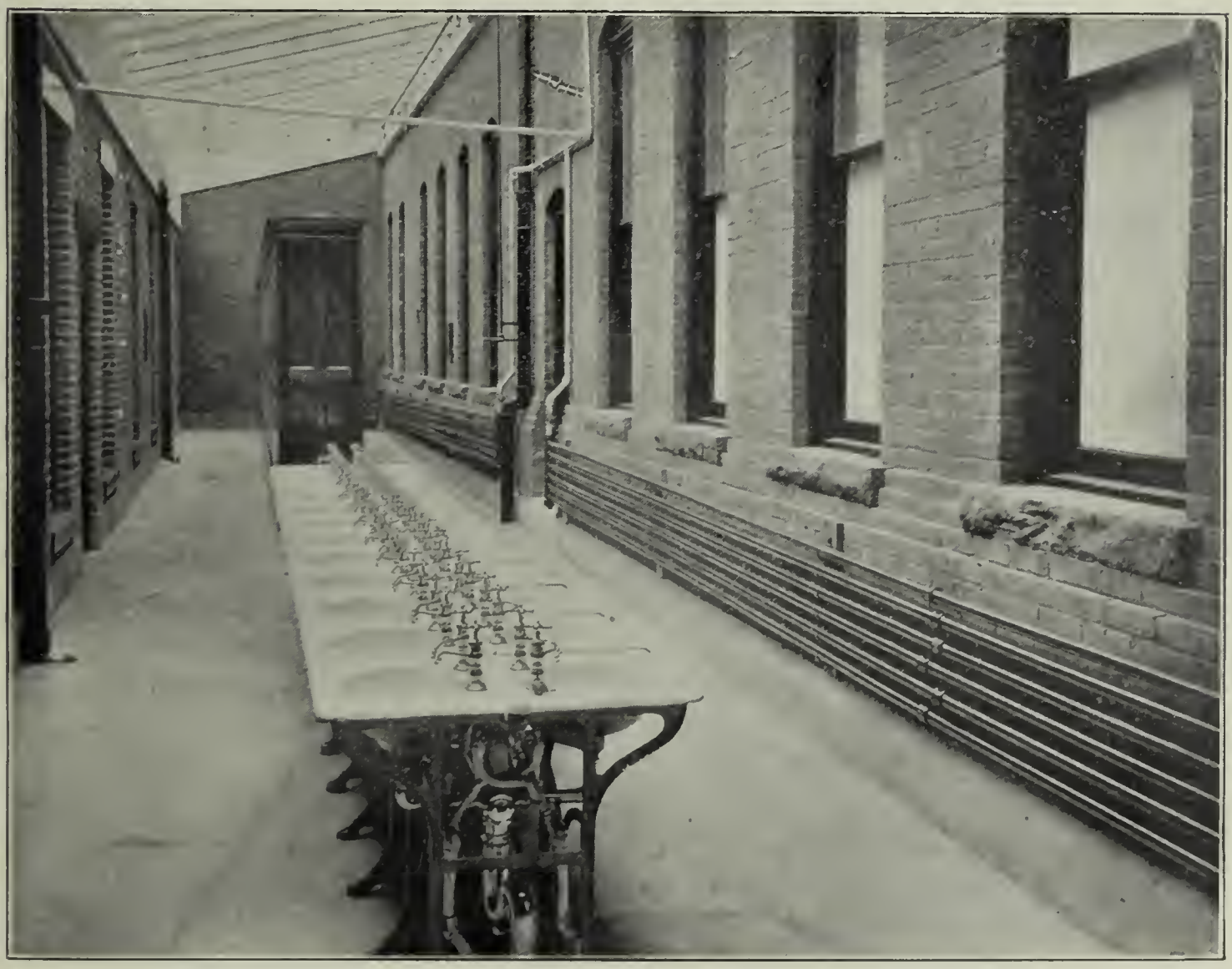
MACHINE WORK AND VISE WORK are taught in a similarity thorough and careful manner.

MODERN MACHINE SHOP METHODS AND APPLIANCES. This subject is taught in the classroom by means of text-books and lectures. The aim is to familiarize the student with up-to-date methods under various conditions of practice and with such machines and appliances as do not come under his immediate observation in our shops.

Machinery and Mill Work receives attention; methods of arranging shops and machinery are investigated, and the transmission of power for shop purposes is studied. Important engineering developments, as they occur, are discussed in the classroom in connection with the studies to which they relate.

Pumping Machinery. A study of pumps of different styles and sizes. Principles of action; principal types; arrangement of parts; proportion, efficiency, etc.

Steam Engine Design. It is the endeavor to have this work conform to the best modern practice, and to supplement the instruction given, by requiring the student to investigate existing engines with regard to their design and construction.



Lavatory, Containing 24 Set Bowls and 188 Lockers.

Blue prints of drawings furnished by prominent manufacturers are also used, and show the prevailing forms of engines in use.

Gas and Oil Engines. Theory and construction of gas and oil engines, ignitors, governors, etc.

COMPRESSED AIR MACHINERY. The study of motors, compressors, hoists and various air tools.

TRANSMISSION OF POWER. A study is made of the various forms of power transmission in shops and factories, shafts, pulleys, gears, couplings, bearings; belts, rope and chain transmission are taken up and studied.

THERMO-DYNAMICS. This includes a study of the laws of thermo-dynamics as applied to steam engines, gas engines, air compressors, injectors and other appliances.

HEATING AND VENTILATION. This work includes the study and design of various forms of heating and ventilation in common use in modern buildings.

INDICATORS. Practice with the steam engine indicator; study of the reducing motion; taking diagrams from engines; calculating the horse power; comparison with ideal diagrams, locating defects in engine by means of the diagram; use of the planimeter.

STRENGTH OF MATERIALS is considered by examining the physical properties of the various materials used in construction.

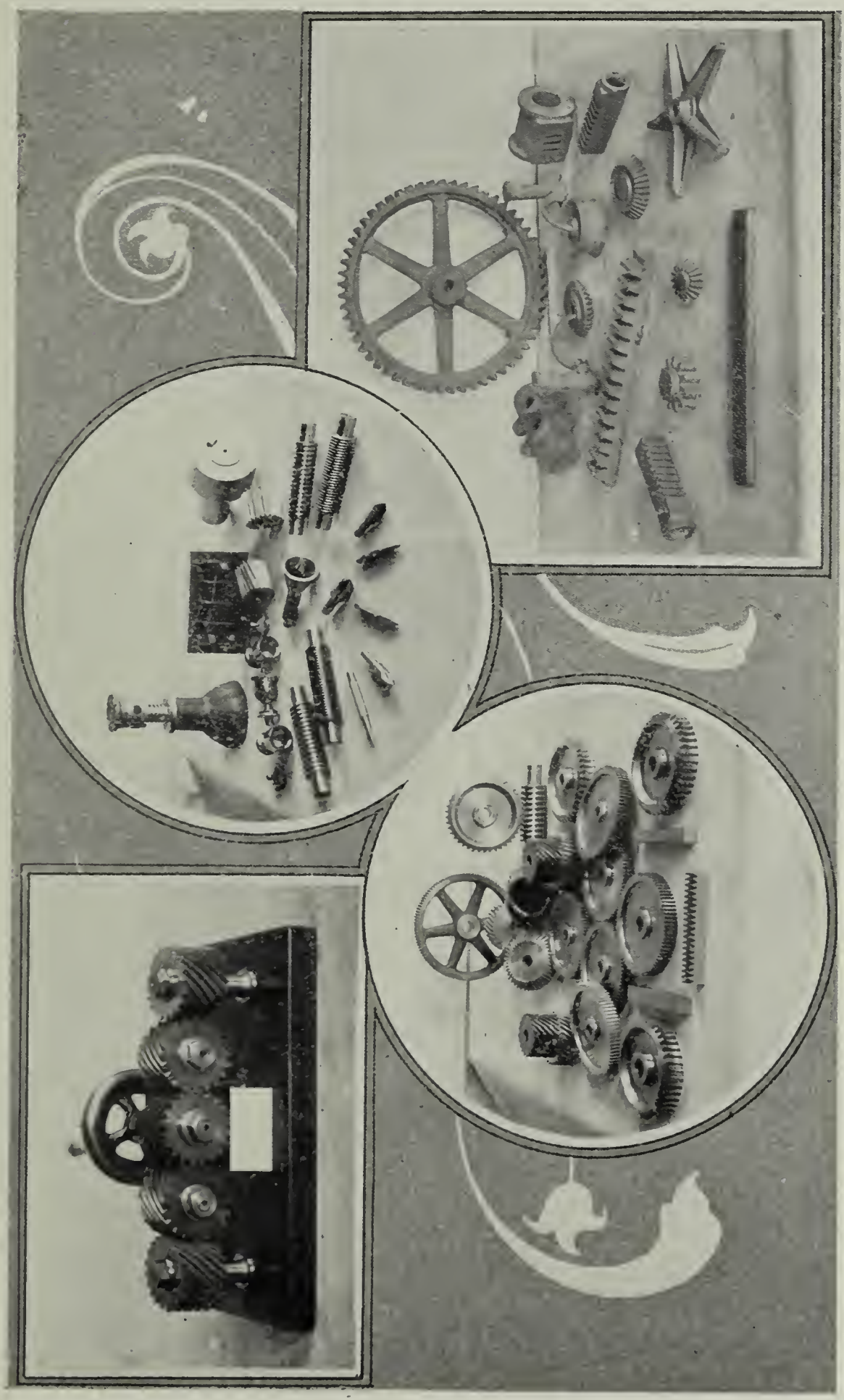
Besides the usual tests of beams, columns and other structural pieces, tests are made of chains, ropes, cables, solid bars and welded bars of iron; force required to drive various kinds of nails; holding power of nails and screws, and strength of bricks, stones, marble, etc.

HYDRAULICS. The study of hydraulics from the theoretical side takes one term. This extends to the laws of gravity as affecting water, principles governing flow through orifices, over weirs, channels, etc., the loss of head through pipes, etc.

PRINCIPLES OF MECHANISM are studied with reference to the combinations of which machines are composed, and the study of designs for the communication of motion by means of gears, belts, links, etc., methods of designing parallel motions, quick return motions and cone pulleys. The adaptation to the formation of gear teeth of the involute, the epicycloid, the logarithmic spiral, and other curves, form an important feature in this course.

The department possesses a large number of models necessary for a presentation of the subject. In many cases they were constructed by the students from their own designs.

RAILWAY MECHANICAL ENGINEERING. The design and construction of locomotives, the operation of the air brake and the study of different forms of signals and switches.



Samples of Students' Work Made in Machine Room and Foundry.

Spiral Gears Made in Machine Room. Various Pieces Made in Machine Room.

Racks and Gears Made in Machine Room. Castings Made by Students in the Foundry.

SPECIFICATIONS AND CONTRACTS. Complete working drawings for some particular problem are made, the specifications are made, and a form of contract for such a problem is carefully worked out. The laws governing contracts and specifications are studied as part of this work.

CONSTRUCTIVE ENGINEERING. The design and arrangement of power plants, shops and factories.

ELECTRICAL MACHINERY. This work embraces the study of various forms of electrical machinery, the adaptibility for different purposes, the arrangement of power plants, light plants and the placing of motors for running single machines.

METALLURGY. Under this head is taken up the study of combustion, fuels, furnaces and refractory materials. Especial attention is given to the metallurgy of iron and steel.

THE STEAM BOILER. The various forms are carefully studied from the best authors.

The College possesses four steam boilers, to which the students have access, as they also have to many boilers owned by outside parties near the College.

The department has samples obtained from different sources of burned and torn sheets from exploded boilers; burned and pitted flues; choked and corroded pipes and fittings, and a large collection of parts of boilers showing conditions incident to boiler management. Injectors, pumps, condenser, feed-water heaters and economizers receive special consideration and are thoroughly investigated.

Chimney draft and mechanical draft are studied and compared with regard to their relative efficiencies.

THE STEAM ENGINE is studied in its various forms in general and in detail. The department has a pair of indicators and all appliances necessary for complete engine tests. Careful attention is given to the study of valves by means of the Zeuner and Bilgram diagrams. Compound and condensing engines are studied with reference to steam distribution and the proper proportion of the various parts. The thermo-dynamics of the steam engine is studied in the Senior year.

There are four steam engines at the College which belong to this department.

The department also has three first class steam pumps and an inspirator. These, with what has already been named, form a desirable equipment for the use of the students.

Three of the steam engines are provided with Prony brakes. There has been added a model to be used in studying the steam engine. It shows the working of a common slide valve, a riding

valve, and the Corliss valves under varying conditions. It was made for the department, and enables the students to get a clear conception of the working parts of the steam engine, especially the valve gearing.

Seminar. The Senior students in the Winter and Spring terms use one hour per week for the consideration of articles of interest appearing in the current technical papers and magazines.

Students are expected to read the current technical literature, and for their accommodation the College library is well supplied with the best engineering papers and magazines.

Thesis. Each student is assigned a subject which he is to investigate and upon which he must write a satisfactory thesis. He is expected to rely upon himself as much as possible.

Visits of Inspection. During the Senior year the students make visits of inspection to the large industrial establishments of the State in charge of an instructor. These visits are intended to be of educational value, and to supplement the work done at the College and to show the students the practical application of many things taught in the classroom.

THE SHOPS

The Shops in connection with the Mechanical Engineering Department are places where principles and operations may be more readily laid hold of and permanently acquired, than any bare demonstration of the classroom could accomplish.

The shop instruction is divided into courses, and in each course is given, in connection with the work, an explanation of the construction of each tool and its manner of acting on the material, the methods of determining how to select materials best suited to different kinds of work, the manner of laying out work, cutting speed of tools, etc.

Bench Work in Wood. This course consists of exercises with the different wood-working bench tools, so arranged in a graded series as to embrace the manipulation of the tools in their various applications.

First, the use of planes in joining, smoothing and getting the piece out of wind, lining off, and the use of saws in cutting across and with the grain, and keeping to line.

Then follows exercises in making a halved splice, splayed splice, keyed splice, open dovetail mortise and tenon joint, small open dovetail joint, lap joint, dowel joint, newel post and handworked rail, panel door, roof truss, box, carpenter's trestle. Instruction is given in making glued joints, inlaid and scraped surfaces.

Students usually work from drawings. Cases, benches, boxes, foundry flasks and a variety of other useful articles are made.

MACHINE WORK IN WOOD. In connection with this course, with the use of tools, is given the most rapid and economical method of selecting and preparing the wood for the machine. There are given examples of straight turning; cutting in and squaring off; concave, convex and compound curves; handles for chisels and other tools, and examples in chuck work in separate and combined pieces.

PATTERN-MAKING AND FOUNDRY WORK. After becoming familiar with bench and machine work in wood, an application of both is made by constructing patterns with due regard to shrinkage, draft and the best method of constructing the pattern so that it causes the least amount of trouble in the foundry. There are given examples of plain work; core work; pulley work; pipe work; gear work; core boxes, their use and construction.

After the patterns and core boxes have been constructed, they are taken to the foundry room by the students, where moulds and cores are made and castings are made in iron, brass, bronze and aluminum.

In the foundry, the students are taught how to charge and manage the cupola, each student pouring for himself the hot metal for the molds he has made.

The management of the brass furnace and core oven is also taught.

Castings of iron, brass and other metals and alloys are made for vises, drafting tables, dynamos, steam engines, engine lathes and other things needed.

FORGE WORK. Students are carried through a series of carefully graded exercises in both iron and steel, working from drawings in each instance. Many pieces are made which are put to a practical use. They are taught how to bend, twist, upset, draw and weld iron and steel, how to anneal, case harden, temper, braze, etc.

A fine power hammer and a power shears are at hand for the instruction and use of students.

Lathe, planer and shaper tools are made by the students in this room; also cold chisels, center punches, smith tools, brass furnace crucible tongs, skimmers and all bolts, braces and other iron and steel work as may be needed.

MACHINE WORK IN METAL. The care and management of tools and their construction are taught.

Cutting speed of tools and proper angle of cutting edge for different purposes and different metals; centering and straightening work; straight turning and squaring, boring; making and fitting joints; chuck work; screw cutting, inside and outside; drilling, tapping and reaming; boring with boring bar and use of center rest;

polishing and finishing; hand-tool work. Every shop exercise is graded and marked in the same manner as a classroom recitation, each piece of work being regarded as of educational value.

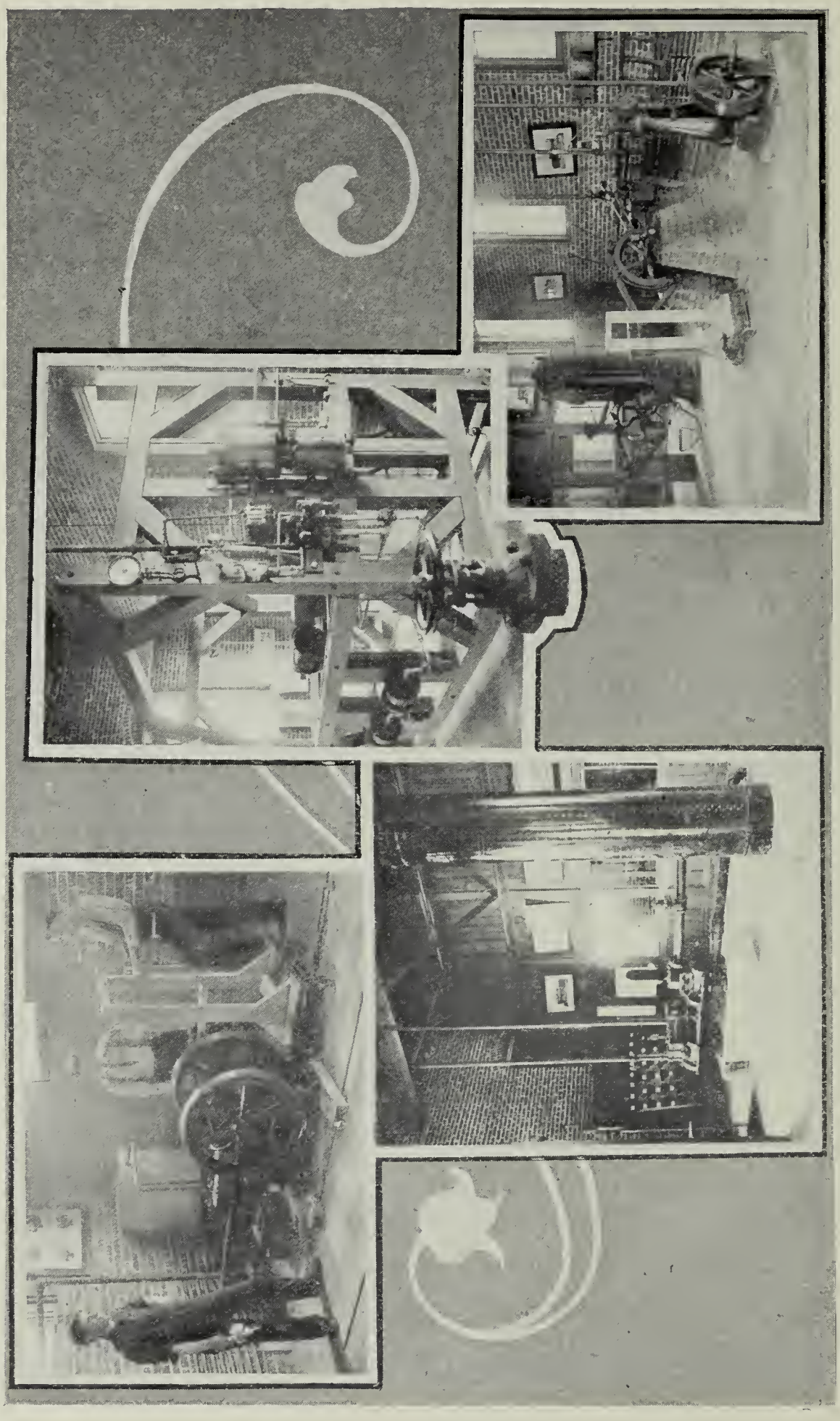
This work is so planned that much of it, when completed, forms some part of a machine or other product. A five-horse power vertcle steam engine complete in all its details, a number of drafting tables, boring bars, gears, vises, bells and small tools for use in the shop, serve to illustrate the practical use to which shop products are put.

Practical Mechanics. For those whose time and means are limited, a short course in practical mechanics is provided. This course covers practically the work of the First and Second Sub-Freshman years.

The work has for its object a systematic and progressive education in the use of tools and materials, combined with as much theoretical knowledge as may be deemed necessary to explain the principles involved. It does not teach special trades or manufacture salable articles; to do so would require that the student be kept on the kind of work that he could do best, and thus prevent him from acquiring broad and liberal ideas of other methods. So, without teaching any complete trade, the mechanical principles of many are gained. This does not necessarily mean that the student becomes sufficiently expert to compete with the skilled mechanic, but that a knowledge of how a tool or machine should be used, and the manner of laying out work for it, are thoroughly taught.

Should circumstances be such as to cause the student to enter manufacturing, his ideas have been broadened by his training, and he will more readily grasp anything new that may come up in his business, or should he take up farming he will, with greater ease, be able to understand the mechanical principles and workings of his machinery, and know how to keep it and his buildings in proper repair.

Tool-Room System. There is a well-arranged tool-room, fitted up with a check system designed to accustom students to order and neatness and the names of the tools in use. Here are kept the gauges, calipers, drills, mandrels, chucks, dies, taps, reamers, and a large collection of the highest grade of machinists' tools, such as are found in a well organized commercial establishment.



Mechanical Engineering Laboratory.

Westinghouse Air Brake.

Steam Engine Arranged for Testing.

Duplex Steam Pump.

Students Testing Gasoline Engine.

Hydraulic and Pneumatic Tower

THE EQUIPMENT

Mechanical Engineering Building. This building includes two large main portions, two stories high, and an ell, one story high.

The first story of the north front of the building is occupied as follows; The east end contains the office of the Professor of Mechanical Engineering. The tool room is in the middle of the south side of the room; it is supplied with a good assortment of small tools, such as taps, dies, reamers, gauges, and milling machine cutters. The tools for cutting, threading and fitting iron pipe are also kept in the room. These tools will handle pipe from one-quarter inch up to two inches. Taps are provided for each size of pipe.

The machine shop is also on this floor and occupies the middle portion of the building. It is supplied with a fine assortment of tools for working the metals. Around the room are benches, with iron vises fitted for the work in chipping and filing.

There are in this room two 16-inch engine lathes, two 17-inch engine lathes, two 14-inch engine lathes, one 13-inch engine lathe, one speed lathe, one 20-inch drill press, one 6-foot planer, one 15-inch shaper, one universal milling machine with gear-cutting attachments, a grindstone, an emery wheel stand carrying two wheels, a universal tool and cutter grinder, a twist drill grinding machine, an emery wheel stand carrying two wheels 16 inches in diameter, a 36-inch grindstone, a 10-inch sensitive drilling machine, and one power metal saw.

An extra bench, standing near the middle of the room, is fitted with a pipe vise and furnished with the necessary tools for instruction in pipe fitting.

At the west end of this story are two well-lighted classrooms used for instruction in Mechanical Engineering. These rooms contain a number of good models. The upper story of this portion of the building is devoted to bench and machine work in wood. There are 37 benches, each supplied with a complete set of carpenters' tools. The other appliances are: One 24-inch surface planer, one 30-inch band saw, one scroll saw, one double circular saw bench, one foot mortiser, one steam glue heater, eight wood-turning lathes, a 16-inch pattern-maker's lathe with compound rest, a wood trimmer, a 36-inch grindstone and a good supply of clamps.

In the lower story of the east main portion of the building is the engine room, containing the 50-horse-power Corliss engine, which furnishes power for the entire plant. This engine is supplied with indicator attachments. The students are given an opportunity to take and work up indicator cards. For this purpose the department has a pair of Crosby indicators. A dead weight gauge tester affords a means of correcting steam gauges.

Opposite the engine room is the lavatory with lockers for 188 students and set wash bowls with hot and cold water supply and room enough for twenty-four students at a time to wash.

The drawing room, which occupies the upper part of this building, has accommodations for fifty students. In the ell portion of the building are found iron store-room, blacksmith shop, and foundry.

The blacksmith shop is fitted up in a most convenient and modern form. There are twenty-five forges, all attached to a system of pipes for supplying a blast to the fires and for taking the gases from the forges. Each forge is supplied with a complete set of smith tools. There are extra tools, sledges, vises, a pair of metal shears and a power hammer.

The foundry is at the west end of the ell and has very complete appointments. It contains a 20-inch cupola, a brass furnace, a core oven, and about 200 flasks of various kinds and sizes. It is well supplied with the necessary bench and floor tools, ladles, shanks, skimmers and a moulding machine. Most of the equipment for this room, including the cupola and brass furnace, was made by the students.

MECHANICAL ENGINEERING LABORATORY. The building is situated directly south of the present Mechanical Engineering building, and is known as the Mechanical Engineering Laboratory. It is 40 feet wide and 60 feet long, and built of pressed brick.

The object of the work of the Laboratory is to give the advanced students an opportunity to make investigations of the physical properties of materials of construction entering into buildings, machinery, and other structures, and also to make tests and examinations of different kinds of boilers, engines, motors, pumps, and all kinds of mechanical appliances which may be obtained for the use of the department. A number of pieces of apparatus have been given by generous parties for carrying on this work.

As a great deal of the work of investigation is along the line of steam engineering, a new 80-horse power boiler is placed in the laboratory in order to have the steam needed close at hand. The boiler is so arranged as to allow of its being subjected to regular commercial and scientific tests, and students are instructed how to find the horse-power, how to test for strength, how to test the quality and quantity of the steam furnished by the boiler, and to obtain its efficiency.

To test the quality of steam, that is, to find out the amount of moisture in it, there are on hand four different styles of calorimeters, a Carpenter throttling calorimeter, a Carpenter continuous calorimeter and a Barrus calorimeter. There is also a calorimeter devised and made by the students. In connection with these calori-

meters there are thirteen thermometers of a high degree of accuracy. These are cylindrical bulb thermometers. There are also several high grade steam-pipe thermometers, designed to get the temperature of steam flowing through pipes.

A draft gauge is also provided for measuring the draft of the smoke stack in connection with the boiler trials. Provision is also made to secure samples of the chimney gases for chemical analysis, in order to assist in ascertaining the thoroughness of combustion of the fuel. The temperature of the gases may also be taken with a suitable instrument which is provided. Several mercurial pressure and vacuum columns are provided. All instruments are carefully calibrated before tests are made with them.

A large tank and weighing scales are provided, so that the amount of water used and turned into steam may be ascertained while the trial is being made. Three steam engines are in the building: One of 12-horse-power, made by the Denver Engineering Company; one of 6-horse-power; another of 5-horse-power; the latter was made by the students. These engines may be run with different loads and at different speeds. Upon these engines brakes are placed, so that the load on the engine may be accurately measured. The students are instructed how to set eccentrics and valves, and how to ascertain the horse-power of the engines. For this latter purpose there are on hand two Crosby steam engine indicators, with five springs each, for varying pressures of steam. Reducing rigs are ready for use with the indicators and are used to make the stroke of the indicators proportionate to the stroke of the engine. There is also a reductor at hand, for the same purpose, made by Schaeffer & Budenburg, New York.

A United States Observatory barometer, made by Henry J. Green, of Brooklyn, is in the building, to be used in connection with the boiler, engine and pressure tests of various kinds. The air-brake appliance, made by the Westinghouse Airbrake Company, is in this building. It consists of a complete outfit for engine, tender and one car, including all the tanks, valves and engineer's valve. Besides using this for the purpose of investigating, the air pump attached is used to furnish air to other kinds of pneumatic machinery. There is also a quick action triple valve, made by the New York Airbrake Company.

There are micrometers and verniers ready for use, which will measure in thousandths of an inch. An ingenious water meter registers the number of gallons of water passing through a pipe in a given time. This is used in connection with the hydraulic work. The planimeter is used for measuring the area of diagrams drawn upon paper, and is used in connection with the figuring out of test diagrams of various kinds. It is of the Amsler design. Revolution counters are used in connection with the engine and the motor tests.

There are three steam pumps in this laboratory, two made by George F. Blake, of New York, the other by M. F. Davidson, of Brooklyn, New York. The setting of valves and the testing of the efficiency of these pumps are features of the work. Nine steam gauges have been presented by different makers, which give a good variety upon which to make investigations. For testing gauges two first-class machines are ready; one for testing pressure gauges, the other for testing vacuum gauges.

A No. 5 Humphryes hydraulic ram affords a good illustration of this interesting piece of mechanism and gives the students an opportunity to make tests.

A steel tower twenty-five feet high and thirty inches in diameter made by the Star Boiler Works of Denver, Colorado, enables the students to do considerable work with hydraulic and pneumatic machinery. It is built to be used at a working pressure of 125 pounds to the square inch.

Two sizes of the Hancock inspirator furnish means of studying this highly interesting instrument. Tables are arranged at convenient intervals in the room at which the students are first required to make their theoretical and mathematical calculations, and afterwards compare the practical results of the tests with these calculations. Tabulated results of all tests are made upon blanks of suitable form.

DEPARTMENT LIBRARY

The department library contains a large number of books of the principal authorities on the subjects relating to the work in engineering; the students have access to these and also to

THE GENERAL LIBRARY

The library contains about 25,000 volumes and about 15,000 pamphlets and other unbound material usually found in a college library.

THEORY AND PRACTICE

Attention is called to the combination of theoretical and practical instruction here offered. Thorough and careful instruction is given with, or is supplemented by, the most practical application of the same in all ways. In every instance where it is possible, the work of the classroom is supplemented by work in a corresponding laboratory, where the experimental work is performed according to the latest and most approved methods with the best machines and materials. The practical applications of mechanical theories broaden the conceptions of these truths and make them easier to grasp and more easily retained; by studying the construction of machines the abstract mathematical laws are better understood and their significance becomes more evident.

DEGREES

Upon those who complete the work of the course in a satisfactory manner, the State Board of Agriculture, upon recommendation of the Faculty of Instruction, confers the degree of Bachelor of Science.

On those who already have the degrees of Bachelor of Science the degree of Master of Science will be conferred on the completion of a course of study which has been accepted by and been under the direction of the Faculty. The course must extend through two years and should include one major and two minor lines of work. The course of work should be accepted as early as October. The subject of the thesis presented should be selected by December, and the thesis itself which should show power of independent investigation, presented by May 1st, preceding commencement.

The degree of Mechanical Engineer will be conferred on similar conditions and for a similar amount of technical work, which must also show the possession of experience on the part of the applicant.

MILITARY

The importance of military training, both to the individual and the State, is so apparent that comment thereon is here unnecessary, further than to say that the physical training and development alone is sufficient proof of its benefits. The growing demand for military instruction in connection with school work, and the fact that the State Agricultural College is the only State institution where such a department exists, has led the authorities to make the work as thorough as practicable.

For instruction the cadets are formed into companies and the companies form a battalion. Each company has a captain, two lieutenants, five sergeants and five corporals. The officers and non-commissioned officers are selected from those in the higher classes showing the most proficiency in the work.

All military exercises are performed in accordance with the United States Drill Regulations.

Practice in artillery drill is had during the spring term. This is instruction in the school of the cannoneer, unmounted, and is in accordance with the United States Artillery Drill Regulations.

The signal corps does practical work in transmitting messages, both by means of signal flags and with heliographs. The systems used are the same as those used in the Government service.

During unfavorable weather theoretical instruction is given with occasional drills in the manual of arms, which can be executed by the battalion as a whole, within the armory.

The department is equipped with 250 cadet rifles, belts, cart-

ridge boxes, bayonets and scabbards; two 3-inch rifled field pieces; National and Battalion colors; swords for officers; signal flags and heliographs; drums and trumpets for a field band of fourteen members.

An officer from the United States Army is stationed at the College by the General Government to give military instruction to the students.

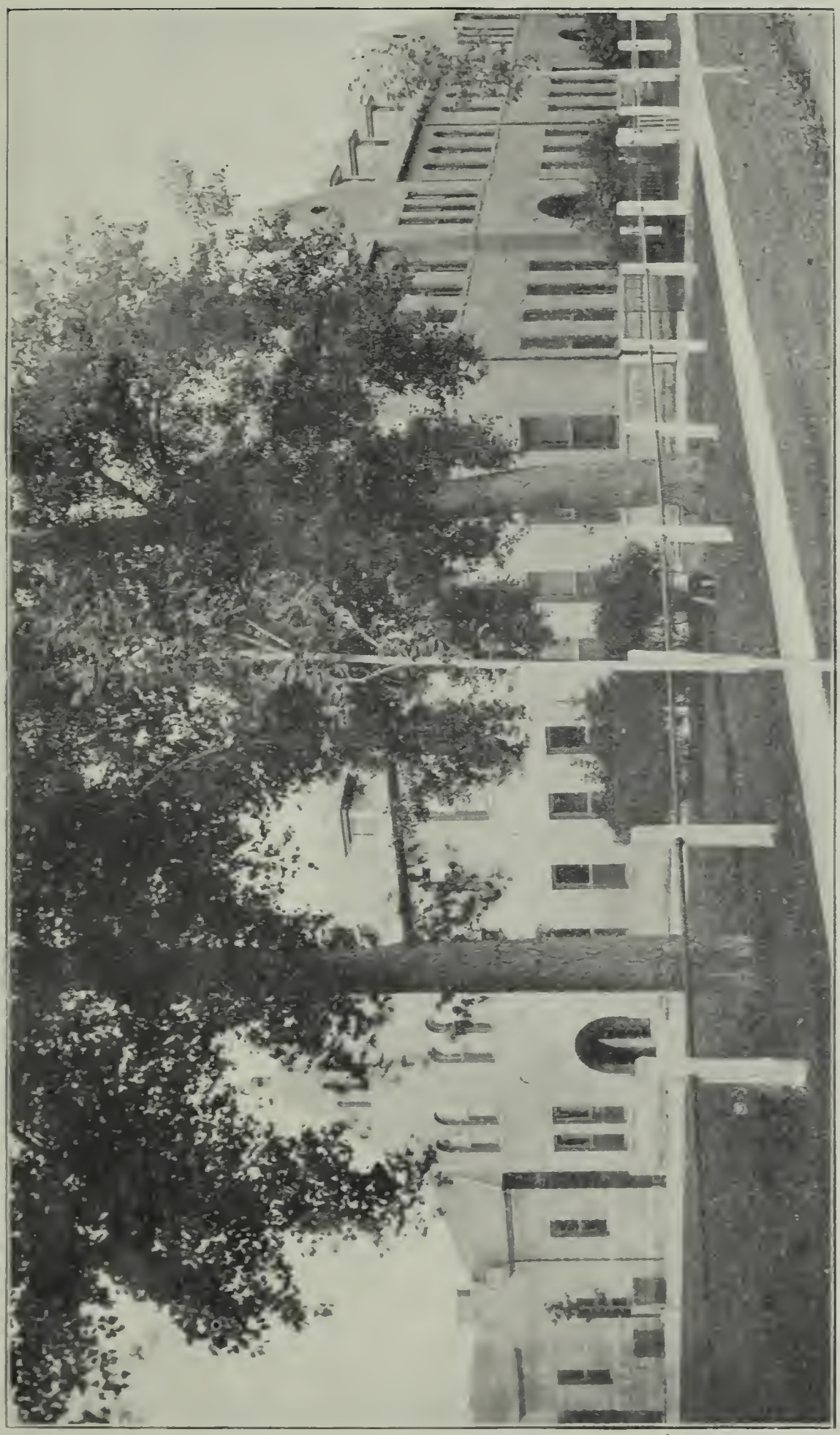
EXPENSES

Tuition in all the regular and special classes of the College is free. There is no charge of any kind for material used in the laboratory work or for books taken from the College library. An entrance fee of three dollars will be required of every student. This will be remitted and passed over to the Athletic Association, upon the written statement of the Secretary of this Association that the student has become an active member of the Association.

The College issues a general catalogue which gives information regarding other courses of study, registration, discipline, athletics, College organizations, boarding clubs, cost of living and much other information useful to those who contemplate taking a College course. Catalogues may be obtained by addressing the President of the College.

For further information regarding the Department of Mechanical Engineering address

J. W. LAWRENCE,
The State Agricultural College,
FORT COLLINS, COLORADO



Buildings of the Department of Mechanical Engineering.