

U. S. Department of Labor.
United States Training Service.

Pamphlets. -----

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| 1. How to Start a Training Department in a Factory. 1-13/4. | 1919 |
| 2. A Successful Apprentice Toolmakers' School. | " |
| 3. Training Labor for Peace Time. | " |
| 4. Labor Turnover & Industrial Training. | " |
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U. S. DEPARTMENT OF LABOR
UNITED STATES TRAINING SERVICE

C. T. CLAYTON, Director

618 Seventeenth Street, Washington, D. C.

HOW TO START A TRAINING DEPARTMENT IN A FACTORY



This bulletin concludes a series of publications issued by the Section on Industrial Training, Committee on Labor, Council of National Defense. All future publications on the subject will be issued by the United States Training Service of the Department of Labor



UNITED STATES TRAINING SERVICE
BULLETIN No. 1



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FOREWORD.

The bulletin which follows was prepared before the organization of the United States Training Service by the Section on Industrial Training for the War Emergency of the Committee on Labor of the Council of National Defense. For 15 months this section had been engaged in promoting the establishment of organized training in the industrial plants of this country, and this material was prepared as one of the series of bulletins which they had been circulating. When the United States Training Service was organized, as part of the War Labor Administration's activities, the chairman of the Section on Industrial Training, Mr. H. E. Miles, came to the service to take charge of its field organization on training. The chairman of the executive committee, Mr. Percy S. Straus, who with Mr. Miles had shared the burden of the active work of the section, came also to be a special representative in the field service, with headquarters at New York. Others of those who had pioneered the idea in this section have taken up phases of the work for this service, and so far as it can the service is carrying on what they so well began.

The text which follows, outlining his experience in establishing a training department for the Curtiss Aeroplane Co. at Buffalo, N. Y., was written by Frank Lawrence Glynn, director of training for the Curtiss Aeroplane Co. and now superintendent in this service, assigned to the fifth training district, which embraces eastern Pennsylvania, southern New Jersey, and Delaware.

It seems proper at this time, in publishing this concluding bulletin of the series issued by the Section on Industrial Training for War Emergency, that due acknowledgment be made by the Director of the United States Training Service of the debt due to the officers and workers of the Committee on Labor of the Council of National Defense whose self-sacrificing efforts have contributed toward the laying of such a good foundation for emergency industrial training in this country, including the chairman of the Committee on Labor, Mr. Samuel Gompers; Mrs. Ralph W. Easley, secretary of that committee; Mr. L. A. Coolidge, chairman of the Welfare Division; Messrs. John Golden and C. R. Dooley, of the executive committee of this section, and others of the Central and the State branch committee.

C. T. CLAYTON,
Director United States Training Service.

18363

FOREWORD.

For the text of these outline courses on lithography, this service is indebted to Mr. A. L. Blue, Assistant in Training Methods, of New York. The data were prepared by two expert lithographers, Mr. Edwin N. Blue and Dr. Charles Perpentì. It was the intention at the beginning to complete these outline courses with a manual for instructors covering in detail the processes of lithography and photolithography, but it has been found impossible to finish this portion of the work during the current fiscal year. It is thought that the matter here presented has sufficient value in itself to justify its present publication. Somewhat different in style and treatment from the other bulletins of this service, these courses are designed as foundational for the guidance of instructors in lithographic processes to be used in the preparation of lecture and demonstration work before classes in established schools. The subject matter of lithography differs from the other productive industries which this service has been studying, and the differences are all of a character that suggest training by classes and in schools rather than through the more direct methods necessitated in the other industries.

If this pamphlet serves to advance sound mechanics and a better understanding of the value of the artistic sense in lithography, it will have met the purposes of this service.

C. T. CLAYTON,
Director.

OUTLINE COURSES FOR INSTRUCTION IN LITHOGRAPHY AND PHOTO-LITHOGRAPHY.

INTRODUCTION.

Granted that the instructor is technically and practically qualified, his attitude toward his work becomes a matter of first importance. The principle which he should keep foremost in mind is that of cooperation, which is no more important in any trade or industry than in lithography. Each operation in the production and sales branches logically follows its predecessor, with which it has a vital connection. Of this essential factor in the industry, each operator should be fully cognizant. His attitude toward the groups of workers engaged upon the processes immediately preceding and immediately following the one upon which his own group is engaged should be that of a cooperator. In a well-regulated shop with a common interest, politics will be eliminated and the men's minds will be kept from aimless drifting into idleness and morbid, narrow channels. Too often a deplorable habit is acquired of "passing the buck" backward, from the printer to the transferrer, from the transferrer to the prover, from the prover to the artist, from the artist to the plate preparer, etc., in order to dodge responsibilities when errors occur.

Taciturn, secretive, "tongue-tied" methods are all too prevalent. No doubt the first man who discovered that sour beer and tobacco were effective in cleaning a stone considered it his secret instead of making his knowledge shop property, so that many minds might seek to find the reason, and clean chemistry might supplant the filthy method which is still used to-day.

The lithographic trade had its beginning in the 18th century and it is remarkable that the methods originally employed remain practically unchanged. Although the principle involved is so simple that the process is probably the most direct of all printing methods, none the less, all phases of the trade call for the exercise of intelligence; its possibilities are limited only by the artist's ability and the honest, intellectual support of the whole shop. All are carrying grist to the same mill. By working together, they may correlate their interests and invest them with the permanence which they deserve. This establishment of mutual interests will be found to promote true efficiency.

To foster the cooperative idea, the instructor should analyze the conditions in the trade. To the store of knowledge which he already possesses, he must ever add the fruits of experience; for, while practical sense is sometimes a natural gift, it is chiefly acquired through experience.

Patience, too, is like many other virtues, it is rarely a gift, but rather demands a constant effort of the will. One obstacle to be overcome in the course of its attainment is the dominance of self-interest. The instructor must strive, without counting the cost, to give his very best to the class. He must learn to conceal his feelings when necessary, and to show them only when they may be of assistance to the student. The successful teacher learns to go slowly, in accordance with the capacity of his students, so that they may learn to walk before they learn to run.

SUGGESTIONS FOR THE INSTRUCTOR.

The ideal lithographic instructor should have technical knowledge, know drawing, color, and perspective, have teaching ability, trade skill, practical shop experience, knowledge of shop conditions and methods, and ability to read and analyze character. Above all, he should know how to reach the student's mind—to "put it across" or, make the student understand because he wants to understand.

The instructor should train himself upon lines of approach. Grade pupils, using the trade value of work produced as bases of comparison. Keep "round pegs out of square holes"; advise those pupils who have chosen a branch for which they are not fitted to shift their course. If a pupil has qualities that would make a good prover, he should not be encouraged to try hopelessly to become an artist.

Dodge theories and schemes that only hamper sound progress. Encourage the actual practice that helps. Take stock of the real situation and develop through experience, not by mere discussions. Avoid bizarre methods; study local conditions and use the direct method of attack. Eliminate wastes of time, effort, and material. For example, have the artist apprentices practice upon paper. Marshal facts as you find them, and base your conclusions upon facts alone. It never pays to guess at a student's progress.

Encourage friendly competition, encourage social functions and mutual advice; make pupils feel that nothing is of more importance than work; that real happiness depends on doing things better than the other fellow, and what they are happiest at they will be likely to do best and at the greatest profit. Have the advancement of pupils count directly toward the boys' finding jobs.

"As is the instructor, so is the school."

The average shop apprentice is not taught the fundamental principles of lithography or the characteristics of materials employed; he just "picks up" his trade. In the shop when a boy learns to do a thing well, he is kept at it. In the school when a boy learns to do a thing well, he is moved on and up. Let this course be always a school to better things and wider knowledge.

Impress on the student the fact that due reverence for the sketch, painting, or copy is of prime importance, for through the various processes—although the lithograph artist is primarily responsible—and running through all operations to the finished product, the sketch is the guide. It is the one silent, unfailing argument that determines whether the reproduction is or is not a faithful copy. It not only determines the quality of work, it is a financial barometer. Unfaithful reproductions, failing in letter or in spirit, probably are responsible for a large percentage of loss to the lithographic trade, through refusals to accept work, or claims for reductions in price made by indignant customers.

The student should appreciate this condition. Show him where it will cost him money if he becomes an employer; how it will incapacitate him as instructor, superintendent, or foreman; how it will hamper his chances as an artist or workman to neglect the design which is his guide. Before all else impress upon the student the asset value of sound pride in his work.

PREPARING STONE AND METAL PLATES.

It may be difficult to get students interested in stone grinding and graining, as so few will choose such a course and the demand for stone preparers is small in comparison with other branches of the trade. It is nevertheless important, as it enables the student to properly choose and test the stone he is to use, and posts him on its possibilities and limitations. It should be learned thoroughly, therefore; and the lesson sheet should be thoroughly quizzed, even though the student does not intend to make this branch his vocation. He must know the surface he will work on.

The advent of aluminum, zinc, and the offset press have opened possibilities and opportunities for the plate preparer that are far-reaching, insuring employment at remunerative wages, far in advance of former years. The scope of the work is larger than formerly and the responsibility greater; consequently this branch is more attractive as permanent employment in addition to its necessity as a preparatory course to more difficult branches of lithography. Plate dealers who have facilities for preparing plates for the trade are calling increasingly for capable men, which is a practical reason for learning to do this work well.

Stone grinding and graining and plate preparing are now amalgamated branches of the trade; this should be explained to the student.

THE LITHOGRAPH ARTIST.

The lithograph artist should be impressed with the importance of a general knowledge of drawing, color, form, and perspective. Attention should be called to the fact that a large percentage of those painters, architects, sculptors, illustrators, mural decorators, and designers who have established reputations in their respective arts, owe their success primarily to the facility and technique acquired in the lithographic shop. Establish in the student's mind the groundwork necessity of thoroughly studying his copy; have him get well acquainted with it before commencing his tracing. The first operation should be the application of his color scale; and from start to finish neatness and cleanliness will be an important factor, one that will save him many corrections and win the prover's approval and cooperation. The student should attend art exhibits, study nature out of doors and indoors; live his art and absorb it as far as possible.

But don't forget that the proof sheets of the work done is the test of progress; no mere words will correct or atone for errors. The only touchstone of success as an artist is found in actual, faithful work.

THE PROVER.

The prover should work in harmony with the artist. He should consult with him; work hand in hand with him. While the copy is the guide, the prover and artist by cooperating can better determine the necessary tones to strengthen or reduce to improve the work. The color scale may have to be deviated from for practical reasons; and thus a bond of interest is established between artist and prover—"a consummation devoutly to be wished." It is an old saying in the shop, "it takes a prover 10 years to see color as it is." Color is the important thing for the prover to know. It is "up to" the in-

structor to impress the student with this fact. If the student is afflicted with color blindness he can not become a prover.

The prover's honest progressive proofs are the pressman's guide. The student should be taught that these proofs are the important thing. Accurate proofs make the job a success; their lack make it a failure. Don't doctor proofs by "thumbing," or by making corrections on the proof sheet, confusing the printer and leading to untold complications. Order, system, and workmanlike precision are the essential virtues of the good prover.

THE TRANSFERRER.

Until this stage is reached corrections are comparatively easy. But after this, look out! For your work goes to the printer, where an error will be a calamity. There may be the necessity of unharassing a press to correct mistakes in size, subject matter, bad register, or inferior work, etc. If the error is not discovered in time, the entire loss of the edition may result. Eternal vigilance is necessary from the time the transferrer puts the original plate on his press to gumming. The uniformity of the result will be almost proof positive that the job is technically right, as it would be more difficult to make duplicates on one plate uniformly bad than good. The keynote of the transferrer's job, then, is responsibility.

THE LITHOGRAPH PRINTER.

Although the transferrer stands between in the sequence of processes, the printer and prover are closely allied, and should consult upon color schemes and how obtained; the prover giving the printer his formula of pigments necessary to produce the required colors on the job in hand. So simple as this seems, it is oftentimes the cause of much discussion and sometimes of ill feeling. Since the same color can be obtained by use of altogether different pigments, the provision of these formulas must be with due deference for differing ideas of color mixing, and fine diplomacy is a good vehicle. The instructor should strongly urge cooperation and united work for the best practical solution of the color problems.

It has been stated that the best aviators are not necessarily good mechanics; knowing too much about machinery seems to divert their minds from the business of flying. The same thing can safely be said of the pressman. While he must understand his press, the important element is that he keep his plate clean, watch his color, register, pressure, and see that the sheets do not offset.

Teach the student not to be "sloppy" and to avoid wastage; to run the press as if he owned it.

OUTLINE FOR INSTRUCTION IN LITHOGRAPHY—FIRST YEAR,

INSTRUCTOR NO. 1.

Covering Lithographic Drawing, Photo Lithography, Chemistry of Lithography.

Students of every branch of lithography will be required to attend chemistry class for a specified number of lectures, prescribed for their special branch of lithography. Chemicals and apparatus should when practicable be the property of the student.

CHEMISTRY COURSE.

This should be a lecture course, given in two weekly lectures preferably of two hours commencing at 2 o'clock on Mondays and Thursdays. The lecture should be illustrated and accompanied by practical demonstrations, and be participated in by all students. The time allotment of students in chemistry class should be as follows:

Students in stone and plate preparing, lithographic drawing and printing, two months chemistry.

Students in transferring and proving, six months chemistry.

Students in photo lithography, one year chemistry.

Teaching: Definition of chemistry, its application and importance to lithography, chemical elements, chemical reactions, chemical composition of stones, zincs, and aluminum. Description of grades of stones, zincs and aluminum. Grades versus adaptability, color, porosity. Influence of thermic and atmospheric conditions. Action of oleic acid, arabic acid, and other chemical agents on stone, zinc, and aluminum.

A series of simple experiments will present the subject in a fascinating manner to the greatest satisfaction alike of student and instructor, and clinch the knowledge that is being imparted. The basis of the whole subject of lithography is incorporated in this outline and will be constantly referred to.

Examples of experiments: Alkaline actions on stone, zinc, and aluminum, acid actions on stone, zinc, and aluminum.

Teaching: Classification, derivation, specific gravity, solubility, affinity, grade, cost, chemical symbols including nitric acid, phosphoric acid, and all other chemical agents employed in the various operations of preparing stone, zinc, and aluminum. All chemicals and compounds to be removed from stone, zinc, and aluminum in the process of restoring the surface; such as tusche, crayon, transferring and printing inks, asphaltum, albumen, silver nitrate, prussiate, potassium, both red and yellow, tannin, stearine, wax, etc.

The chemical action of solvents—chloroform, ether, turpentine, benzole, carbolic acid; physical and chemical characteristics of carborundum, emery, flint, sand, water, etc. Use the microscope as an aid in creating interest and making a lasting impression. This part of the subject should be covered in 16 lectures, to discharge stone and plate preparing, and lithographic drawing and printing students.

Advanced study of oleic, arabic, and nitric acids, etc. Chemical actions and properties of oil of lavender, oil of hyoscyamus, oil of lemon, etc. Action of light, thermic and atmospheric influence.

Fifty-sixth lecture: Discharge, transfer and proving students.

Lithographic drawing students' course—First year schedule.

INSTRUCTOR NO. 1.		Months.
Monday:		
8 to 12 a. m., lithographic drawing.....		12
1 to 2 p. m., lithographic drawing.....		12
2 to 4 p. m., chemistry.....		2
2 to 4 p. m., Ben Day machine.....		10
Tuesday:		
8 to 12 a. m., photolithography.....		12
1 to 4 p. m., lithographic drawing.....		12
Wednesday:		
8 to 4 p. m., lithographic drawing.....		8
8 to 2 p. m., lithographic drawing.....		4
2 to 4 p. m., printing inks ¹		2
2 to 4 p. m., printing papers ¹		2
Thursday:		
8 to 12 a. m., lithographic drawing.....		12
1 to 2 p. m., lithographic drawing.....		12
2 to 4 p. m., chemistry.....		2
2 to 4 p. m., Ben Day machine.....		10
Friday:		
8 to 12 a. m., original research.....		12
1 to 3 p. m., photolithography.....		12
3 to 4 p. m., care of apparatus.....		12

LITHOGRAPHIC DRAWING—FIRST YEAR.*Nineteen hours weekly for eight months.*

Apparatus.—Ben Day machine, ruling machine, stereopticon. Care and operation of each machine to be mastered.

Fifteen hours weekly for four months.

The tracing: On gelatine, with pen, with needle; on paper, with pen, with conté crayon. Stereopticon tracings. Inking in gelatine; tracing with various mediums. Squaring; adding registry marks; proving marks. Color blocks, after tracing has been transferred to stone, to zinc, or to aluminum. Practice tints in crayon, in stipple. Filling in simple solids on jobs. Counter-etching stone, zinc, aluminum. Teaching principles of lithographic drawing; laying due emphasis upon its importance. Assisting transferrer to clean transfers and to join tints and solids and work up tints on light colors. Operation of ruling machine. Starting light colors; yellow, light blue, buff. Working up tints on more important colors. Beginning to gum out. Start work on pinks and grays; finish upon yellows, light blue, buff. Work up blacks, dark blue, and reds. Use of the Ben Day machine. Reduce process prints in yellow, light blue, and buff.

FIRST YEAR IN PHOTOLITHOGRAPHY.

Teaching: Elementary optics—the lens and its elements; filters; the microscope; the spectroscope. Colloids; chromates; photo chemistry; photo physics; light; color.

Apparatus.—The care and operation of lens, camera, plate holder, hydrometer, bath tank, printing frame, vacuum frame, whirler, lamps, switches, fuses.

Arrangement and care of chemicals and apparatus in dark room. Dark room ventilation. Lighting.

¹ Instructor No. 2.

Physiological and poisonous effects of chemicals employed. Individual idiosyncracies. Substitution of chemical agents as a measure of protecting health and as a matter of economy.

Glass washing; albumen coating; preparation of developers—cyanide, copper, silver, iodine, sodium, and ammonium sulphide; iodized collodion; plain collodion; rubber solution; rubber and collodion coating; stripping; inserting; joining; paper prints, silver printing, and bleaching; sunlight papers; lighting; line negatives, wet plate process; albumen printing on stone, zinc, and aluminum; preparation of sensitizing solutions; albumen, glue, asphaltum; coating and printing on stone, zinc, and aluminum. The silver bath, bath care, bath tests; recovering wastes; making lantern slides.

Lithographic drawing students' course—Second year schedule.

INSTRUCTOR NO. 1.		Months.
Monday:		
	8 to 12 a. m., lithographic drawing.....	12
	1 to 4 p. m., photolithography.....	12
Tuesday:	8 to 4 p. m., lithographic drawing.....	12
Wednesday:	8 to 4 p. m., lithographic drawing.....	12
Thursday:		
	8 to 12 a. m., lithographic drawing.....	12
	1 to 4 p. m., photolithography.....	12
Friday:		
	8 to 2 p. m., original research.....	12
	2 to 4 p. m., care of apparatus.....	12

LITHOGRAPHIC DRAWING—SECOND YEAR.

Apparatus.—The care and operation of: Air brush; air-brush accessories.

Familiarize student with choice of grain textures on stone, zinc, and aluminum. Take up the importance of and the method of making a color scale. Finish study of pinks and grays; pass proofs; start reds, dark blue, black. Classify your students. Assign special work to special students according to individual ability or aptitudes. Finish red, dark blue, and black.

Estimation of time required for the lithographic drawing. Familiarize the student with the cost of the lithographic drawing, material, maintenance, space, and losses accompanying chemical processes.

Operate the air brush; pass press sheets.

Engraving and lettering.—To be taught by a specially appointed instructor to special students.

Lithographic drawing, 22 hours weekly for 12 months.

PHOTOLITHOGRAPHY—SECOND YEAR.

Apparatus.—The care and operation of: Soxlet tube; halftone screen and holder.

Photolithography, 6 hours weekly for 12 months.

Original research, 7 hours weekly for 12 months.

Teaching: The halftone screen; manufacture; thermic effect on the halftone screen; importance of cleanliness; halftone screen position in the plate holder; the application of the principle of geometrical projection to the production of the halftone dot; screen distance;

camera extension; the diaphragm; exposure; division of exposure; developing the halftone plate; halftone collodion; finishing the halftone plate; grain screens; the master screen; theory of color and light; illumination; superimposed printing on stone, zinc, and aluminum; printing by projection on stone, zinc, and aluminum; the flood light; parallel rays or spot lights; color separation.

The dry-plate process.—Choice of plates; the color sensitive plate; dyes, development, and finishing of half-tone negatives. Line negatives; continuous tone negatives; paper negatives; positives from positive printing.

Temperature of water.—Its effect on the albumen print. Chemicals affecting the albumen print.

Asphaltum printing.—Elimination of inorganic substances. The Soxlet tube, process of asphaltum coating; printing; developing asphaltum prints; etching prints.

INSTRUCTOR NO. 2—FIRST YEAR.

Covering: Stone and plate preparing; lithographic printing; lithographic transferring.

Machinery.—The care and operation of the lithographic proving press.

Stone and plate preparing, four hours weekly for three months.

This instructor will conduct a two months' course of lectures on Printing Inks, attended by all lithographic students, beginning the first week of the fourth month, on every Wednesday, from 2 to 4 p. m.

Lithographic printing inks.—Process of manufacture. Chemical composition; the effects of the chemical ingredients of inks upon stone, zinc and aluminum. Recognition of ink troubles. Causes. Modifications. Causes justifying rejection of inks. Thermic action upon inks; chemical action on printed pigments. Light action on vegetable pigments.

Lithographic proving, 24 hours weekly for three months; 22 hours weekly for two months; 26 hours weekly for two months; 30 hours weekly for two months.

This instructor will follow the lectures on inks, commencing the first week of the sixth month, every Wednesday, from 2 to 4 p. m., by a lecture on printing papers, to be attended by all lithographic students.

Printing papers.—Processes of manufacture, paper-making materials; bleaching; handmade papers; machine-made papers; effect of ingredients on stone, zinc, and aluminum. Effects on printing pigments.

Chemistry lecture: four hours weekly for two months.

Inks lectures: two hours weekly for two months.

Paper lectures: two hours weekly for two months.

Apparatus: two hours weekly for 12 months.

Original research: five hours weekly for 12 months.

Lithographic proving students' course—First-year schedule.

	Months.
Monday:	
8 to 2 p. m., proving	6
2 to 4 p. m., chemistry	6
8 to 4 p. m., proving	6
Tuesday: 8 to 4 p. m., proving	12
Wednesday:	
8 to 4 p. m., proving	8
8 to 2 p. m., proving	4
2 to 4 p. m., printing inks	2
2 to 4 p. m., printing papers	2
Thursday:	
8 to 2 p. m., proving	6
2 to 4 p. m., chemistry	6
8 to 4 p. m., proving	6
Friday:	
8 to 2 p. m., original research	12
2 to 4 p. m., apparatus	12

LITHOGRAPHIC PROVING.

Teaching: Importance of cleanliness; good order; care of machinery, tools, and accessories.

Mechanism of the hand press; bed, tympan, scrapers; the selection of scraper wood; the scraper leather; care and selection of leather rollers; breaking in new rollers; roller handles; scraping and sand-papery rollers, solvents for cleaning rollers; the rubber roller, its advantages and care.

Selection of gum arabic crystals; preparation of plain gum solution; the specific gravity of gum-arabic solution; straining the gum-arabic solution.

Cleaning up stone, zinc, and aluminum preparatory to etching; applying acid resists preparatory to first etch; final cleaning and application of acid resists preparatory to second etch; damping stone for prover; observation of rolling-up process; pulling offset impressions; making offsets.

Effects of acidulated gum-arabic solution on stone, zinc, and aluminum; drying etched surface; effects of spontaneous drying; effects of forced drying on stone.

Third month.—Dismiss lithographic transfer students from lithographic proving class. Lithographic proving students; importance of registry; consideration of crayon and touche work preparatory to etching. Consideration of resisting quality of albumen print, preparatory to etching. Make up progressive book, etching stones, washing out with asphaltum, rubbing up image.

Principles of consistency of color.—Its application to special conditions; to various paper surfaces; to cardboard.

Proving yellow and other light colors. Adjusting scraper pressure. The trial print: its significance. Counter etching of stone, zinc, and aluminum.

Consideration of the required number of good finished proofs.

Number of starting sheets necessary to meet requirements, and to furnish a set of progressive proofs.

Prove jobs in one, two, three, four, and five colors.

LITHOGRAPHY AND PHOTOLITHOGRAPHY.

INSTRUCTOR NO. 2—SECOND YEAR.

Lithographic proving, 24 hours weekly for 12 months.

Original research, 7 hours weekly for 12 months.

For the first three months, assign lithographic proving student to the lithographic transfer department, to study principles and requirements of transferring and for the purpose of encouraging cooperation and eliminating departmental friction.

Lithographic proving student's course—Second-year schedule.

	Months.
Assign proving students to transfer department for three months.	
Monday, 8 to 4 p. m., proving.....	9
Tuesday, 8 to 4 p. m., proving.....	9
Wednesday, 8 to 4 p. m., proving.....	9
Thursday, 8 to 4 p. m., proving.....	9
Friday:	
8 to 2 p. m., original research.....	12
2 to 4 p. m., apparatus.....	12

Apparatus.—The care and operation of: Offset proving press.

Teaching: To prove work requiring five or more colors, and bronze.

Time estimation; drying methods; drying mediums. Time required for the drying of printed colors.

The offset proving press.—Press mechanism, the registering device, operation; pressure, the rubber blanket, manufacture, cost, grade, chemical composition, chemical reaction, care of the rubber blanket; cleaning solvents; proving from stone, zinc, and aluminum.

INSTRUCTOR NO. 2—FIRST YEAR.

Covering stone and plate preparing, proving and transferring.

Proving, 24 hours weekly for 3 months.

Transferring, 22 hours weekly for 3 months; 26 hours weekly for 1 month; 28 hours weekly for 5 months.

Chemistry lectures, 4 hours weekly for 6 months.

Inks lectures, 2 hours weekly for 2 months.

Paper lectures, 2 hours weekly for 2 months.

Apparatus, 2 hours weekly for 12 months.

Original research, 5 hours weekly for 12 months.

Lithographic transferring student's course—First-year schedule.

	Months.
Monday:	
8 to 2 p. m., proving department.....	3
2 to 4 p. m., chemistry.....	6
8 to 2 p. m., transferring.....	3
8 to 4 p. m., transferring.....	6
Tuesday:	
8 to 4 p. m., proving department.....	3
8 to 4 p. m., transferring.....	9
Wednesday:	
8 to 4 p. m., proving department.....	3
8 to 2 p. m., transfer department.....	4
2 to 4 p. m., lithographic inks.....	2
2 to 4 p. m., lithographic papers.....	2
8 to 4 p. m., transferring.....	5
Thursday:	
8 to 2 p. m., proving department.....	3
2 to 4 p. m., chemistry.....	6
8 to 2 p. m., transferring.....	3
8 to 4 p. m., transferring.....	6
Friday:	
8 to 2 p. m., original research.....	12
2 to 4 p. m., apparatus.....	12

LITHOGRAPHIC TRANSFERRING.

Apparatus.—The care and operation of: Stone transfer press; offset transfer press; reducing and enlarging machine.

Teaching: Starting in the first week of the fourth month, with the layout. Transfer papers, paper costings; thermic and atmospheric influences on transfer paper; grain of paper and its influence on registry; principles and preparation of transfer inks; chemical composition; modification of transfer inks by the addition of oil of lavender, oil of hyoscyamus, oil of lemon, oil of olive, oil of palm; importance of cleanliness; treatment of stone, zinc, and aluminum surfaces with alum, bicarbonate of soda, acetic acid, nitric acid, and pumice powder.

The damping book.—Damping gelatine tracings; pulling impressions; importance of uniformity of impressions.

INSTRUCTOR NO. 2—SECOND YEAR.

Lithographic transferring, 28 hours weekly for 12 months.
Original research, 7 hours weekly for 12 months.

Lithographic transferring students' course—Second year schedule.

	Months.
Assign students to press room for three months.	
Monday: 8 to 4 p. m., transferring.....	9
Tuesday: 8 to 4 p. m., transferring.....	9
Wednesday: 8 to 4 p. m., transferring.....	9
Thursday: 8 to 4 p. m., transferring.....	9
Friday: 8 to 4 p. m., original research.....	12

Teaching: Sticking up impressions on layout sheet; consideration of gripper, pulling over transfer on stone, zinc, and aluminum; varying pressure; damping; removing paper; rubbing up; cleaning; application of acid resists; etching.

For three months assign lithographic transfer student to the pressroom. The time of the student in the pressroom may be divided into three weeks on the stone press, three weeks on the rotary press, and six weeks on the offset press.

Teaching: Pulling impressions from engravings on stone; pulling impressions from metal plates; inserting; making up originals; the torch; operating reducing and enlarging machine; coating for rubber sheet; taking the impression; various methods of transposition; time and cost estimation.

INSTRUCTOR NO. 2—FIRST YEAR.

Covering: Stone and plate preparing; hand stone graining; hand polishing.

Stone and plate preparing: Machinery, 28 hours weekly for 3 months; 17 hours weekly for 5 months.

Hand stone graining, 7 hours weekly for 3 months; 10 hours for 4 months.

Hand polishing, 7 hours weekly for 1 month.

Chemistry lectures, 4 hours weekly for 2 months.

Ink lectures, 2 hours weekly for 2 months.

Paper lectures; 2 hours weekly for 2 months.

Plate preparing, 2 hours weekly for 8 months.

STONE AND PLATE PREPARING.

Teaching: Protection of work on back of stones.

Machinery: The grinding machine; mechanism, operation, care, backing thin stones; importance of uniform thickness; testing stones, quality of stones; process of grinding.

The stone graining machine.—Mechanism, operation, care, leveling stone; hand graining, polishing stones; solvents for the removal of old work.

The planing machine.—Mechanism, operation, and care.

Plate graining machine.—Mechanism, operation, and care.

Accessories.—Quality and care of accessories; care of tools; chemical preparation of plate surfaces before and after graining; effects of forced and spontaneous drying of zinc and aluminum plates; thermic, chemical, and atmospheric effects on zinc and aluminum.

Lithographic stone and plate preparing students' course.

	Months.
Monday:	
8 to 2 p. m., stone and plate preparing machinery.....	6
8 to 4 p. m., stone and plate preparing machinery.....	2
2 to 4 p. m., chemistry.....	2
Tuesday:	
8 to 4 p. m., stone polishing.....	1
8 to 4 p. m., stone graining.....	3
1 to 4 p. m., stone graining.....	4
Wednesday:	
8 to 4 p. m., stone and plate preparing machinery.....	6
8 to 2 p. m., stone and plate preparing machinery.....	2
2 to 4 p. m., paper lecture.....	2
Thursday:	
8 to 2 p. m., stone and plate preparing machinery.....	6
8 to 4 p. m., stone and plate preparing machinery.....	2
2 to 4 p. m., chemistry.....	2
Friday:	
8 to 2 p. m., original research.....	8
2 to 4 p. m., plate preparing.....	8

PLATE PREPARING.

Teaching: Grinding by hand; polishing; use of hand levigator; the production of a grain on stone, local grain, practical cutting of stone.

The preparation of a zinc and aluminum plate surface is of great importance in offset printing. It has a direct bearing on size of edition, printing quality, as an economic factor where large ink surfaces are to be printed. It is largely responsible for the successful production of photo lithographic work.

INSTRUCTOR NO. 3—FIRST YEAR.

Lithographic stone and plate preparing, 4 hours weekly for 3 months; 24 hours weekly for 3 months; 22 hours weekly for 2 months; 26 hours weekly for 2 months.

Chemistry lectures, 4 hours weekly for 2 months.

Printing ink lectures, 2 hours weekly for 2 months.

Paper lectures, 2 hours weekly for 2 months.

Lithographic press room students' course—First-year schedule.

	Months.
Monday:	
8 to 2 p. m., machinery.....	2
2 to 4 p. m., chemistry.....	2
Tuesday:	
8 to 4 p. m., machinery.....	10
Wednesday:	
8 to 2 p. m., machinery.....	8
2 to 4 p. m., printing inks.....	2
2 to 4 p. m., printing papers.....	2
8 to 4 p. m., machinery.....	4
Thursday:	
8 to 2 p. m., machinery.....	2
2 to 4 p. m., chemistry.....	2
8 to 4 p. m., machinery.....	10
Friday:	
8 to 4 p. m., original research.....	12

OPERATION OF THE LITHOGRAPHIC STONE PRESS.

Teaching: Operation of the delivery device; handling of paper; slipping in sheets; washing up; removal and return of inking roller; care of damping apparatus; care of blanket; care of press; importance of lubrication; setting the stone; levelling the stone; setting the stone for cardboard printing; setting the stone for imprinting on paper; care of stone surface; mechanism of the inking device; mechanism of the damping device; color mixing consistency of the inks; modification of inks.

MECHANISM OF THE PRESS.

Study of the main parts.

Bed plate.
 Frame (left).
 Frame (right).
 Belt pulley.
 Small driving pinion.
 Main driving gear wheel.
 Main driving shaft.
 Cylinder cams.
 Main crank.
 Driving rod.
 Under rack.
 Rack wheel.
 Bed rack.
 Bed slides and
 Rollers.
 Belt.
 Ink table.
 Side shaft.
 Cylinder brake cam.
 Gripper cam.
 Roller distributing cam.
 Water motion.
 Main cylinder.
 Delivery cylinder.
 Sheet wheels.
 Fly strings.
 Fly sticks.
 Fly string, cleaner.
 Main cylinder grippers.
 Fly cylinder grippers.
 Jack and cam.
 Front guides.
 Side guide.
 Blanket hooks (front).
 Back rod and
 Ratchet.
 Inking rollers,

Roller sockets.
 Gears and
 Thimbles.
 Adjustable stone bed.
 Impression and locking up.
 Ink duct.
 Fountain pawl.
 Right bed racks.
 Left bed racks.
 Roller rack.
 Water fountain.
 Roller.
 Water ductor roller.
 Brass roller and
 Dampers.
 Belt to driver water roller.
 Brake attachment.
 Motor and
 Controller.
 Fly cam.
 Fly lever.
 Screws and lock nuts.
 Distributing rollers.
 Riders.
 Ink fountain roller.
 Ink fountain frame.
 Ink fountain knife.
 Ink fountain set screws.
 Cylinder trip motion.
 Double roll gearing.
 Automatic counter.
 Fly spring.
 Sheet tongues.
 Front bands.
 Back bands.
 Slide lever.
 Pillar and steady teeth.

Teaching: Setting the stone; mixing the ink; washing out the work; taking the impression; finding registry; setting rollers; setting fly sticks; cylinder cam and throw-off motion; vibrating rollers on main ink rollers; double roll attachment; the McKinley roller; principles of pressure; amount of ink; minimum amount of moisture; improving thickened work; improving weakened work; probable cause; counter etch; wrinkling of paper; improving registry on expanded paper.

Bronze printing.—Mechanism and operation of machine; the order of printing bronze; double rolling and the cause of using it; setting off; prevention of setting off; causes of inaccurate register; local alteration on stone; printing simple jobs in one and more colors; comparative study of types of presses.

The lithographic press presents the best opportunity for the study of planographic printing. The student must be thoroughly trained in the physical and chemical principles involved; the care and mechanism of his machine; mechanical interference; with the quality and quantity of production; causes and preventions.

INSTRUCTOR NO. 3—SECOND YEAR.

Covering: The rotary press; the flat bed offset press; the rotary offset press; and automatic accessories.

Rotary pressroom, 28 hours weekly for 3 months.

Offset pressroom, 28 hours weekly for 9 months.

Original research, 7 hours weekly for 12 months.

ROTARY PRESS.

Teaching: Advantages over stone press; mechanism, the frame, plate cylinder, impression cylinder, inking mechanism, damping mechanism, feeding and delivery-mechanism, slow turning motion; care of plate; clamping plate, fountain solutions; etching; counter-etching; printing simple colors; automatic cutting device; comparative study of types of presses.

THE FLAT-BED OFFSET PRESS.

Comparison with lithographic stone and lithographic rotary presses.

Teaching: Method of converting the offset press to a direct printing machine; transfer of offset cylinder; impression cylinder; feeding and delivery mechanism; prevention of doubling; conversion to direct press.

THE ROTARY OFFSET PRESS.

Special features distinguishing it from other presses. The similarities to the direct rotary press; feeding mechanism; delivery mechanism; registering device; gear marks.

AUTOMATIC ACCESSORIES.

Automatic feeders: principles of operation; comparative study of types of automatic feeders; the Harris feeder; the Slogger feeder; the Dexter feeder; the jogger; the automatic counter.

SANITATION AND HEALTH.

Sanitary rules and health-protective measures should conform to the rules and regulations of the local health department. Department industrial sanitation. Study of special measures to be provided when conditions warrant.

SHOP RECORDS.

The following forms are suggested to be used for keeping shop records of attendance:

No.	Entered	191
Student	Age	At trade	years.
Shop	Date of registration card		191
Foreman	Address		
Days	Nights		
Class: Stone and plate preparing	Lithograph artist		
Prover	Transferrer	Printing	
Planing machine	Photolithograph printer		
Graining machine	Glass washing		
Grinding machine	Proving		
Plate graining machine	Transferring	{ Color	
Hand graining		{ Commercial	
Hand polishing		{ Feeder	
Stone storage	Stone pressman	{ Tender	
Plate storage		{ Feeder	
Crayon	Rotary pressman	{ Tender	
Stipple		{ Operator	
Process	Offset pressman	{ Tender	
Ben Day	Bronze feeder		
Line and half-tone operator	Bronze tender		

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U. S. DEPARTMENT OF LABOR
UNITED STATES TRAINING SERVICE

C. T. CLAYTON, Director

COURSES *of* INSTRUCTION
FOR
WORKERS IN COTTON MILLS



Including directions for installing a training department
and a summary of information which every worker
in a cotton mill should possess

21

TRAINING BULLETIN No. 25



WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

FOREWORD.

The following bulletin outlines methods for training workers in the textile industry.

For that industry, as for other established manufacturing lines, excellent technical schools provide adequate courses of instruction for those possessing means and leisure to utilize them. From these schools come an increasing proportion of the highly qualified technical leaders and executives in the textile industry. But practically none of the operatives in cotton textile mills are able to avail themselves of these advantages. It is to meet the need of that great body of citizens now employed in textile work and increasing in numbers year by year that this bulletin has been written. Textile mill operatives for the most part are under the economic necessity of continuing at their work without interruption. For them, extensive courses in textile making or any other subject are practically out of the question. Yet they are entitled to an opportunity for self-betterment.

The most practical means so far devised for meeting this need is systematic industrial training, conducted in the factory at the employer's expense, upon such methods as are here outlined. These methods may be considered as an introduction to the more searching analyses by the established schools and may well be supplemented and extended through part-time or continuation schools where the communities affected provide such benefits.

The outlines incorporated in this bulletin are for training the great numbers of beginners who annually join the textile working ranks to replace those who drop out, and for experienced operatives desiring to increase their proficiency in any of the occupations in cotton or knitting mills.

Acknowledgment is due Mr. Alfred A. Mercier, assistant in training methods and expert upon textile training, for the material embodied in this bulletin. Mr. Charles H. Pierce, of Biddeford, Me., Mr. William S. Lowe, of Laconia, N. H., and Mr. Fred Lavigne, of Saco, Me., with Mr. John H. Moss, an officer of this service, from Putnam, Conn., have contributed much valuable material and suggestive advice relating to these courses. Thanks of the service are due to Mr. Philip S. Tuley, president of the Louisville Cotton Mills Co., who placed the facilities of his plant at its disposal.

C. T. CLAYTON, *Director.*

COURSES OF INSTRUCTION FOR WORKERS IN COTTON MILLS.

ORGANIZATION.

TYPES OF TRAINING.

Three different types of training are suggested for cotton mills: Centralized training, training on the floor, and a combination of centralized training and training on the floor.

Centralized training.

This type of training is given upon machines centralized in a room or partitioned space of the factory either for complete training, which will produce trained workers ready for the production floor, or for preliminary training, to be completed on machines installed on the production floor. Because of the size of the machines used in the textile industry, it is probably easier to provide preliminary training on centralized machines and finish training on the floor. This is especially true on these machines:

Pickers.	Combers.	Cotton mules.	Warpers.
Cotton cards.	Fly frames.	Twisters.	Slashers.
Drawing frames.	Ring frames.	Spoolers.	Weaving.

These are the machines usually used in cotton mills. It may be observed that because of the size of these machines, the number of such machines usually operated by one person and the difficulty and expense in moving some of the above machines, setting aside of machines for complete training would hardly be warranted. Some of the above machines may, however, be set aside for preliminary training for the learner, and the same machines used for upgrading, for training fixers, and also for training such special operatives as oilers, etc.

Training on the floor.

Where the machines are too bulky for separate training, or the expense of moving the machinery is not warranted, or where the time of training on a machine would be short and could be accomplished in a few days, the training probably could be accomplished with least expense on machines already installed on the production floor, as on pickers, cotton mules, spoolers, warpers, slashers, etc.

Combination of centralized training and training on the floor.

There may be machines for instance, the Jacquard loom, each of which is operated by one person that may be used for complete training, some used for preliminary training, but all working for the training of the learner in all branches of the industry. The instructors would have charge of both the training on the floor and the separate training, making a combination of both in the training department.

Such machines as cards, drawing frames, ring spinning, and weaving, where several are operated by one person, could not be installed for complete training, but a few may be installed for preliminary training. When machines are set aside for this type of training, other operations should be taught in connection with the general operations. Where card machines have been set aside for preliminary training of strippers, they could also be used for training card grinders; where drawing frames, fly frames, combers, ring frames, or any machine is set aside for preliminary training, they can also be used for the training of fixers, oilers, and for upgrading the workers.

The type of training is usually determined by the executives of the factory with regard to the amount of machinery on hand, the floor space which may be required, and the type of workers needed through training. The branches having most turnover will also be a factor in determining the type of training.

LINES OF AUTHORITY IN MANAGEMENT OF TRAINING.

In order to have a successful training department it will be necessary to have a director, who should assist in establishing the department, have charge of training, and be responsible for the department, the operation, and its production. The training department must pursue its purpose without unnecessary friction or delay, must have learners in process, and keep the machinery in operation. The executives of the factory should give the director authority to make the necessary alterations, secure learners, etc.

The director may be responsible to one of the higher officials as to the policies of the training department, regarding the type of training which may be best suited for the plant or factory, the necessary machinery, instructors, supplies, learners, etc.

He should be responsible to the superintendent or manager as to the operation of the department, consulting him regarding the learners, routing of supplies, repairs which may be necessary at times, use of machinery for training on the floor, authority to use the necessary supplies when training on the floor and access to the rooms where such training is in progress.

MATERIAL SUPPLY.

Where training is to be on the floor, there should be no difficulty in keeping the machines supplied with material for operation, as the machines will be part of the regular equipment of each room and should work in conjunction with the other machinery.

But where the training is to be in a separate room or behind a partition, the material necessary to keep the machines in operation will probably have to be supplied from the production of some other room, arrangements being made that this material may be obtained when necessary. If a few card machines have been separated, it will be necessary to have laps occasionally for the operation; and if a few looms have been set aside, it will be necessary to have warps and filling.

Other supplies will also be necessary for the machines in the separate training department, such as lamps, tools, cleaning material,

INSTRUCTION FOR WORKERS IN COTTON ~~MILLS~~

and auxiliary supplies. These supplies should be furnished regularly so that there will be no interruption in the training operations, no idle machines waiting for repairs, parts, etc.

LOCATION AND LAYOUT.

The location of the training department will depend largely on the type of training adopted, which will in turn depend somewhat on the amount of floor space available.

Where the training is to be on the floor, the training of the learners should be on machines in one end of the room or on a row of machines located near the windows. Machines that are located at one end or side of the room will have better light, there will be less noise, and the learner will find it much easier to get accustomed to the working conditions.

Some of the training may be on machines set apart in a "vestibule." This vestibule should be centrally located or in a place to which the supplies can be routed without interfering with the regular factory routine. If cards, drawing frames, fly frames, combers, ring frames, and weaving be separated, they should be installed in that portion of the factory where the necessary supplies can be furnished and the production delivered without interference and yet be well routed.

Perhaps the best results will be obtained by placing machines in such a vestibule, because in most cases the learner has never worked on such machines; they seem strange, and the learner must get adjusted to the working conditions and the noise of machinery. In such a separate department there will be less embarrassment from new surroundings or stares from other employees, more freedom from disturbances and better light, and therefore the learner will be able to concentrate easier and will more quickly become familiar with the operations on the machines. The training will be more thorough because stress will not be laid on production; the training will also be more varied, as the machines may be used for training learners, upgrading the workers from the factory, and for different classes of operations on the same machine. When machines are set aside, factory production can not be expected, because the machines are not organized as a complete unit and because they must be stopped at times when giving information or teaching settings and adjustment.

When training fixers and oilers, it will not be necessary to interfere with the regular production, as would be the case if such training were performed in the factory. The different settings of rolls and adjustments of parts will necessitate the taking apart of machines, and this may be done in the training department, where there are few machines, to better advantage than in the factory, for there it would stop production as well as interfere with the duties of other operatives.

EQUIPMENT.

Where the training is to be wholly on the floor or finished on the floor, the machinery already installed in the room will be used. The director will make arrangements with the superintendent or foreman for the use of such machines as are necessary for training.

Where the training is to be separate, the machinery will have to be transferred from the regular production departments of the

factory. As in the former case, the director will arrange to have the machines transferred and installed in the training department. This machinery should be of the standard make used on the floor and in good condition. Where factories are contemplating training, it may be that they have old machinery which they have been planning to remove and replace with newer type. This machinery should not be used for training purposes. A learner trained on an obsolete machine and sent into the factory would have to learn the new machine—largely start over. The same reason which caused the removal of a machine from the factory would apply to its use in training department; this may be because of cost for repairing, lack of production, etc.

Provision should also be made for keeping the machinery used in the training department in repair. The machines that are being used for training on the floor may well be repaired by the special operative who has charge of the repairs of the rest of the machinery in the same room, as the machines will probably not be in use constantly for training, and this repairing may constitute part of his regular work when machines are not in use for training. (When machines are to be used part of the time for training, that does not imply that they will be stopped or idle any of the time. The machines will be used for training when learners are needed in that particular department, and as soon as training is finished, the learner will be employed in that department.)

Repairs on machinery that is separated or installed in a training room may be made by one of the operatives who may be called in for necessary repairs, or by one of the training department force. This will depend somewhat upon the number of machines installed in the training department and upon the size of the training force.

Whether repairs are to be conducted by a special operative from the factory or by one of the training force, facilities for repairs should be available, such as permission to use the necessary tools, grinding wheels, etc., and the necessary repair parts furnished when requisitioned by the director or instructor, to be finished by the repair men.

DISCIPLINE.

Each factory has rules and regulations regarding conduct and deportment, information, suggestions, etc. The rules of the training department should be the same as those of the factory, although perhaps the close observation which is usually given each learner, will develop improvements on the factory rules.

These rules should be read to the learner or posted where the learner may read them. Another method is to assemble the learners occasionally, giving them talks or lectures regarding the rules, policies, information, or any other subject that should be made known to them. Where training is to be entirely on the floor, these rules and information would probably be best imparted to the individual learner, as the whirl of machinery will conflict with the assembling of several learners and such assemblies would hinder the operation of the machines.

Such rules concern punctuality, absence from work without permission, quitting, loyalty, cooperation with fellow employees, and

INSTRUCTION FOR WORKERS IN COTTON MILLS.

with the factory, responsibility, enthusiasm, pride in work, suggestions, etc. It is in the training department when the learner's mind is plastic that right impressions may be given.

CHIEF OF INSTRUCTORS.

The staff will consist of a number of instructors and a director who will have charge of the department, controlling the teaching of the necessary information, and the records showing progress of each learner and the cost of the department.

The director should be selected because of his ability to install the training department and to keep it in operation after it has been started. He should have knowledge of the different branches of the industry; should know the principles of training and how to apply them. He should be patient, have plenty of "pep", initiative, should be neat in appearance, courteous, active and must plan the work.

The duties of the director will be to install training when and where needed, to procure instructors for the branches that are to have training; to see that these instructors understand the duties of instructing, and have the necessary data covering the subjects which they are to teach; to prepare equipment and tools for the learners; to have supplies ready for the machines; to interview learners or otherwise ascertain that they are adapted to their work; to have supervision over the assistant instructor and to have general charge of the training department.

Chief instructor.—It may be that the director will be the superintendent or manager of the factory and can not give his whole time to supervise the training department. It probably will then be necessary to have a chief instructor who will have direct charge of the training. He should be chosen for ability and similar qualities to those required of the director; he would have charge of the training department; have supervision over the assistant instructors and assist the director. If the director is busy part of the time on other duties, the chief instructor will have charge and when assisting, will see that the assistants have the necessary information and are imparting it to the learners; that the machines are ready and have supplies; that the learners are progressing as they should; and will assist in any department or branch that is somewhat behind in the schedule; will keep records and make reports daily or weekly to the director or the superintendent.

There may be more than one instructor in the same branch or new instructors put on at times, so it is necessary to have standards by which the instruction may be carried on no matter who may be instructing. These standards may be arranged by the director with the chief instructor; director, chief instructor and assistants; with staff of instructors and foremen or with some of the staff and foremen. In establishing standards, much information and help may be obtained by consulting foremen of the branches where such instruction is to be given.

Assistant instructors because in direct personal relations will probably be the persons held directly responsible for the progress of the learners. The assistant instructor must have thorough knowledge of the branch in which he is to teach understanding all the

details, motions, operations, difficulties, when machines are in good order and when good quality of work is being produced. He must be able to impart this knowledge to the learner in a minimum time, including all necessary information; and to see that the learner becomes proficient both in the performance of these operations and in general knowledge of the machine. The assistant instructor is usually picked from the best operatives on the production floor and while he may be a very efficient workman, he will need some methods to impart his knowledge. He should have a schedule of the duties about each machine, a list of all the necessary operations on the machine, and be instructed how to teach these as well as the operations and difficulties that will come up later when the learner has gone to the production department. He should also study and be qualified to teach the correct manner of performing the operations; should give information regarding rules, policies and anything which should be imparted to the learner. It is important that the assistants have patience, sympathy, that they be of cheerful disposition. They should make the learner feel at ease and willing to come to them with any questions or difficulties, as a gruff or harsh answer may cause a learner to stop asking questions and tend to delay progress in understanding. Assistants and instructors should also be willing to listen to any suggestions.

INTERDEPARTMENTAL RELATIONS.

Employment service.

The training department must be in constant touch with the employment department because much of the work of the training department will depend upon the number of employees required by the production department. All learners or new hands will probably come through the employment department and be sent to the training department for trial, learning or adjustment.

A great deal of the training in textiles must be on the production floor, and to anticipate the demand of the production department for workers, the employment department will have to keep the training department supplied with learners, so that learners may be trained and ready when the time arrives for their going into the production department.

Arrangements may be made with the employment department routing learners either to the production department or back through the employment department. Routing will depend on the system of cooperation between the employment and training departments.

Production department.

It is necessary that the training department work in cooperation with the production department because of the need of the necessary machinery, either to train learners, or to complete the training of those who have received preliminary training in the training department. (Among the machinery in the training department there may be a few spinning frames that have been set aside for preliminary training for spinners, who have learned upon them the necessary operations, cleaning and oiling, all information, etc., but to complete training to acquire speed, it will be necessary to use groups of machines installed on the production floor because of the number

INSTRUCTION FOR WORKERS IN COTTON MILLS.

usually operated by one person. Hence the necessity for cooperation so that training will not decrease production or interfere with routine of spinning room.)

The training department must cooperate with the production department also regarding supplies for machines, such as roving for spinning, warps and filling for weaving and yarn for knitting. Arrangements must also be made for the disposal of the training department's product.

After the learner has been transferred to the production department, records should be kept for a time as a follow up and submitted to the training department for its information and to complete records of training.

FUNCTION OF THE TRAINING DEPARTMENT.

AIMS IN TRAINING.

No matter how simple an operation may seem, there must be a certain amount of teaching, whether given by another operative or learned "on the job." There are questions regarding starting and operating any machine. The function of the training department is to give all necessary information about operating machines; what the machines will do; why work is done in a certain way; and to see that the learner performs the operations in the right way to the satisfaction of the instructor.

The learner should first be made to realize the reason for training, to give the learner through a competent instructor more information that could otherwise be had. The learner will better appreciate the reasons for quality as facilitating the next operation and the final product, and the value of the best method for performing the tasks.

The learner should also understand that the factory desires the best and is willing to cooperate with the learner and employee by giving training and imparting this knowledge to get best results, and that in getting quality they will also get better production, thereby benefiting the learner also. He should be impressed with the responsibility of the part the workers occupy in the organization, that they are a link in the chain of operatives, typical of the textile industry, and that the strength of chain depends on the strength of each link.

Accuracy should be the first consideration in the actual operating of machinery. "Anything worth doing at all is worth doing well." One of the chief objects of training is that the instructor give the learner the full and correct information, so that he will know all of the difficulties that will probably come up in his future work. In teaching accuracy a *best method* will develop, and by performing the operations repeatedly according to this method, the movements will become somewhat automatic and then attention can be devoted to speeding up. In training it is very important that full information be given, and that the learner put it into practice, performing the operations to the satisfaction of the instructor.

Production should not be sought until the learner understands the purpose of the machine, all its operations, and the accurate way of performing them. The learner then operates the machines in this correct manner, after which he should be encouraged to speed up, so that when going onto the production floor, he will be able to keep the required number of machines in operation; if paid according to the

production, the learner, now being one of the workers, should be able to earn wages paid the experienced operative. The learner should progress rapidly where there has been a properly defined method of operating the machines, and should reach maximum speed in a very short time.

SHOP METHODS TAUGHT.

While one purpose of the training department is to give beginners a thorough training which will enable them to produce quantity and quality with the least effort, it is also the purpose of the training department to upgrade those already in the factory, not thoroughly familiar with their machines and who may be somewhat backward because of wrong methods. Also may be used to instruct operatives in other operations, so they may be promoted as vacancies occur.

How it is accomplished.—As has been noted, the type of training will depend on the size of machines, size of factory, the type of machinery used and the number operated by one person. In a small mill where training is to be installed, there probably would be but few machines of a kind, and so there would not be much demand for learners in some branches; therefore, the instructor having charge of training in other lines could also teach in these branches. Every beginner going on machines should be instructed and the instruction should be uniform in methods and principle.

The first thing will probably be to determine which branches are to have training. This is usually regulated by the influx of beginners or the need for upgrading.

After the branches most needing training have been decided upon, it will be necessary to pick out instructors. Some of these branches can be combined under one instructor so that he may give his whole time to the training department. Take for example, the card room; the largest turnover may be on cards and fly frames. The instructor on fly frames may not have enough machines or learners to occupy his whole time, so he may take the cards and instruct on those and may also teach on drawing frames. There may be a few machines of each set aside and the instructor in the carding may teach on the whole of them and do it efficiently.

An important feature in training is to adapt learners to their work, or to find out on what machines they will be most efficient.

Where there is an employment department this adaptation may be done by it, but after entering the training department, it may be found the learner is better fitted to some other branch than that to which he was first assigned.

The training department can also determine who are unfit. These eliminations which it recommends will overcome much of the loss from operatives unable to earn a living wage even though they make more effort than the most efficient.

A list of the different subjects on which the learner should be taught follows:

- (a) Purpose of machine.
- (b) Starting and stopping.
- (c) Safety.
- (d) Operations by best methods.
- (e) Difficulties—bad work and its causes.
- (f) Cleaning and oiling.
- (g) General care of machine.
- (h) Factory rules, regulations, policies.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

(a) Purpose of machine.

The purpose of machine will include the manner in which the working parts are operated, the passage of stock through the machine, the relation of the machine with other machinery in the factory, with regard to the stock which is being used, the necessity for quality, and why the machine operates in a certain way.

(b) Starting and stopping.

This part of the learning is important to the learner because of natural timidity in starting any machine. The learner should practice starting and stopping the machines before performing actual operations, thereby overcoming his natural fears.

Also another reason for teaching "Starting and stopping" is that many machines have certain distinctive features. Some must be started gradually; others have some parts started before the whole is put into operation. In stopping these same conditions apply.

(c) Safety.

The learner does not know the possible dangers of a machine and should be taught what they are, where accidents may happen, how they may happen, and how to avoid them. A large percentage of the accidents in industries are caused by ignorance regarding working parts of machinery. In teaching safety, the possible places of accidents are pointed out; such as belts, gears, and rolls. How to avoid accidents by not removing covers or coming in contact with moving belts or parts is also explained. Women should be taught to do up the hair and wear their clothing so it will not get caught in the machinery.

(d) Operations.

Operations differ on the different machines and they constitute the bulk of the training. They should be listed and analyzed so they may be taught and a record kept of each pupil's work. In teaching the learner should actually perform the operations. Take, for example, spinning.

Operations	Creeling	Removing empty (nearly) bobbins from creels.
		Replacing and piecing on full bobbins.
		Best method in performance.
	Piecing	Removing bobbin from spindle (best method).
		How to catch yarn under traveler and replace bobbin.
		How to piece up at rolls (best method).
	Doffing	How to let down rail, fasten and ship belt.
		How to give slack to ends—push back separators.
		How to wind builder motion back.
		How to remove full bobbins, replace with empty.
		How to pull back separators, to start frame after doffing.
		How to piece up broken ends.

The above will constitute the chief operations, and in keeping the learner's record it should be noted that creeling, piecing, and doffing have been taught. There are other operations that will come up during the training, such as putting on travelers when one flies off, removing waste from the scavenger rolls, etc., but these will not require special training.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

(e) Difficulties, etc.

In teaching operations, it will benefit the learner to know what makes bad work and the difficulties which will be experienced while on the production floor after leaving the training department, as this will eliminate much of the breakage of machinery, spoiling of product, increasing the knowledge which learner receives before going into the factory. Take, for example, spinning: The learner should be taught not to make long splices, not to let singles pass through with the good yarn, to know uneven yarn, to know when ends are breaking because of bad rolls or spindles are out of center, etc.; he also should know that soft bobbins are caused by loose bands or undue vibration of the spindles, etc.

By thus explaining the difficulties the learner learns to detect bad work, its causes, and how to remedy it.

(f) Cleaning and oiling.

As machines in most factories have to be kept free from lint, dirt, and accumulating waste, the parts to be cleaned should be taught, the time for cleaning, how the frames are cleaned, and the material used for cleaning purposes.

It is necessary to keep the parts clean so that the waste will not pass in with the good work, working parts will not be jammed and broken, and they will be kept free from binding. The dangers of cleaning while the machine is in operation must be emphasized.

The oiling on many machines is performed by a special operative, but the learner should know what parts are oiled, when they are oiled properly, and the hours for oiling. On many machines the operative will have to oil certain parts himself, and it is therefore necessary to teach the amount of oil to be used and to wipe off the excess oil, as lint will accumulate on oily surfaces.

(g) General care of machine.

The purpose of teaching the learner the general care of the machine is to avoid unnecessary breakage such as is caused by leaving tools or parts on aprons, cotton, and catching between rolls or gears. It is important that no metal objects come in contact with fine points, as on combers (needles on half lap, points of top comb, etc.) or on card cylinder or doffer, etc. Teach the learner to avoid removing cotton that may be wrapped around rolls by cutting with a knife, as that may cut and injure the rolls and cause the cotton to continually wrap around rolls until they have been smoothed again. The learner should be taught to use care in handling the different parts, and to avoid accidentally putting brooms or cleaning material between gears or rolls. By telling the learner these facts much breakage will be avoided.

(h) Factory rules, policies, etc.

The factory rules come under the heading of discipline, but the best time to teach these rules is when the learner is in the training department, where suitable record can be made of the fact. (See sample record card on pp. 17-19.)

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ANALYSIS OF BEST METHODS.

In all operations there is a best method of performing the necessary duties, and the place to impart this best method is the training department. The learner usually has no method at all when coming into the training department and will get the immediate benefit of the study of these methods because he has no wrong ones to overcome.

The first step would be to list all the operations necessary to each machine.

Then list the different motions in each operation and pick out the best. These best ways of performing operations are then taught.

Assuming that the instructor is a first-class workman, he should know all the operations. However, by listing them he will be sure to give all of them to the learner. Some of these operations may not come up during the actual performance of duties while in the training department but will be needed on the production floor.

The learner should know how to perform all the duties to the satisfaction of the instructor. The quickest manner of learning is *by doing*. A learner in the training department not only learns by doing but also acquires related information of much value.

RECORDS.

To determine the value and the progress of the training department, it will be necessary that records be kept, such as records of the individual's progress. Records should be kept of the training department as a whole, such as records of production, records of what has been taught, of cost, and of the individual after going into the factory from the training department. These records should be clear, giving necessary information as to attendance, admission and dismissal, progress, cost, etc. With these records any executive or official can obtain necessary information and, should any of the staff be removed, they will help a new instructor continue the work.

The individual's record should contain information that may be used in the training and adaptation, such as name, address, date of birth, place of birth, education, branch for which best fitted, etc.

The records should show date of admission and adaptability physically and intellectually. (If not fit for one branch applicant may be fit for another branch, and if recommended for elimination the record should show the reason.) Records should also show what has been taught, and the date and progress in operations and production. There should be a record of quizzes or examinations and amount of time taken to learn each job.

These records will show how long it takes to become proficient on each job. Proficiency will be ascertained by comparing the progress of the learner with the production of the experienced workers.

Besides records of the individual, it will be necessary to keep records of the training department. These will include records of admission of all learners and dates of same; assignments to different branches; the number of learners in each branch; time usually required to train in each branch. The date when learners will be ready for the production department should also be shown.

Records of the individual are kept to enable the instructors to determine the progress of each, to prepare a schedule, and to compare this progress with the schedule and to determine the fitness of the learner for the production floor. These records will also enable the staff to study their work, with a view to bettering it and to prove the worth of the training.

Other records should be kept to show training turnover due to failures or exits. The failure to complete may be due to elimination or incapacity of the learner, illness, etc., and the exits may arise because the learner has been transferred to the production floor or has gone elsewhere.

The turnover record is valuable in determining why and where the workers go, so that the reasons may be remedied and the training grow more efficient.

In some cases records of requests from the employment service may be kept, but this will depend on the relation of that service with the training department.

Cost records should be kept and will include the pay roll of the learners and instructors. They will determine the cost of the training in the department as compared with the cost of training by the usual method.

The cost of material should be kept. This will be governed somewhat by the type of training, as training on the floor will be on machines that are part of the regular equipment and the material used will be part of the regular stock. The cost of such material as is used in training can be estimated approximately. If the training department is charged with this material, the production of the machines will offset the cost of the material.

Where the material is obtained from another department a record should be kept of the cost, but the training department should receive credit by the amount of production. If no unnecessary waste is produced this credit will offset the cost of the material. There may be waste or material which may be used again and which the training department should receive credit for.

Cost of power should be kept where the machines and motive power are separated from the factory. This will also be part of the expense of training. Where the training is done on the floor, this cost may be ascertained, since each machine requires a known amount of horsepower for operation. Where the training on the floor is for short periods the cost of power may not be enough to warrant record in detail.

Other cost records should show the cost of repairs, of labor on such repairs, and of material used. There should be few repairs in the training department, as the operations will be under the supervision of the instructors, who will seek to avoid breakage. Breakage is usually caused by ignorance, although some of it may be due to defects in the material. The record of these repairs will reveal the parts of machinery that are broken most often and the reasons for the breakage.

Follow-up.—As most textile mills will train wholly on the floor, or will give the preliminary training on a few segregated machines and the remainder of training on the floor, it will be very important that the follow-up record of each individual be kept for the information of the training department.

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This record will include the number of machines which the learner operates or his production after leaving the training department; the increase in number of machines he operates or production, and dates. These records will be of great value in improving methods.

To summarize: The records of the training department should show how long it takes to train a learner, the progress of each learner, and how much it costs. They should also show the fitness of learners, reasons for transfers and liminations.

.....
(Name.)	(Date of birth.)	(Branch.)
.....
(Address.)	(Date of birth.)	(Place of birth.)
.....
(Date admitted.)	(Date discharged.)	(Reason for discharge.)

Attendance	Date	Spindles						Hours	Spindles	Hours
		6/2	6/3	6/4	6/5	6/6	6/7			
High avge.	1,200									
	960									
	720									
	480									
Low avge.	120									

REMARKS:

(PROGRESSION CHART.)

(FRONT.)

What is to be taught.	Date	Date and what is taught.	Remarks, quizzes, and examinations.
A. Purpose of machine.	6/2	A. M.—A—B—C—H—D—I. P. M.—C—D1—D—2EF—G.	
B. Starting and stopping.	6/3	A. M.—A—C—D1—D2—E—F—G. P. M.—C—D1—D2—E—F—G—H.	Quizzed: A—B—C—E. General understanding: Good.
C. Safety.	6/4	A. M.—A—C—D1—D2—E—F—G—H. P. M.—D1—D2—E—F—G—H.	
D. Operations.			
E. Difficulties and causes for bad work.			
F. Cleaning and oiling.			
G. Care of machine.			
H. Rules and regulations.			
D-1. Creeling.			
D-2. Piecing ends.			
D-3. Doffing.			
D-4.			
D-5.			

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BRANCH (Spinning.)

(BACK.)

Names.	Date admitted.	Date discharged.	Number of days training.	Cost of training.	Credit production.	Net cost.	Remarks.

(SUMMARY OF BRANCH.)

Week ending

REPORT OF TRAINING DEPARTMENT.

Branch or department.	Total in training.	Number admitted.	Number rejected.	Number to production.	Total remaining.	Total net cost from pay roll.	Cost of instruction.	Total net cost of training.	
Carding.....									
Spinning.....									

INDIRECT EXPENSE.

Repairs.
Clerk.
Etc.

PICKERS.

The first operations in most cotton mills begin in the picker room, where the machines are somewhat alike in purpose and operation, so that in teaching a learner for the picker it is advisable to teach on all machines, that the learner may be available for a variety of work in that room.

(a) Purpose of machines.

In teaching the learner on pickers, the purpose of the machines should be explained, that it is mainly to open and clean the cotton, remove dirt and seeds, and to form laps for the cards. A general idea how this is accomplished should be taught, because the action of parts of the machines are invisible to the eye, and the learner should know something of what is happening when the cotton is going through these processes.

(b) Starting and stopping.

The learner should be taught just what parts are to be started first and how they are started. That to start the beater by shipping the belt from loose to tight pulley *slowly and gradually* because of the weight of the beater, also because of the high speed which it must attain; then starting other parts. How to start the feed and calender rolls by the drop lever, and which are usually stopped by the automatic stop measuring motion, which is used in making laps of the same length.

(c) Safety.

A learner is usually timid in starting and operating a machine because he is afraid of it. A learner on any machine should know its dangers and how to avoid them. The dangerous parts are usually guarded, but the worker sometimes becomes careless or forgetful and removes the protection, laying himself liable to accident. The learner should be taught never to lift the beater bonnet while the beater is in motion, although the bonnet usually has a safety device so that it can not be lifted while the beater is in motion, but the learner should be informed of the danger that lurks here and should be warned of moving belts, to avoid coming in contact with belt clamps, lacing, or rough edges; he should be warned of the dangers of gears; since gears are covered with casings the latter may be removed; hence there is liability of catching clothing, cleaning material, etc., in them. He should be warned of dangers of rolls, due to the fact that they are weighted and may draw the clothing or even a limb between them.

(d) Operations.

1. The first operation would be that of mixing the cotton, opening and loosening it, and it is usually done with the bale breaker or opener. If the bale breaker is used, or the cotton mixed in bins, the learner should know the reason why the cotton is mixed and loosened and the correct way in feeding the bale breaker, as well as the process which the cotton passes through.

2. The cotton is then put into openers. The only operation here is to keep the hoppers about two-thirds full at all times while the opener is in operation, so there will be cotton in the hoppers all the time. In some mills the opener is connected with the breaker picker and others have a trunking system between these machines, the cotton being delivered into a condenser or gauge box, which is used to prevent thick and thin places in the lap when starting and stopping the breaker.

3. The operator on the breaker picker usually tends several machines, his duties being to remove full laps, to make or start new laps, to thread the cotton through the screens, stripping rolls and calender rolls, this operation being necessary when the feed has been stopped, perhaps by the apron sticking, or the machine undergoing repairs, or for other reasons.

4. The operations on the intermediate and finisher picker are practically the same and consist in placing full laps on the aprons at the back, doffing full laps at the front, threading the cotton through the screens, stripping rolls, calender rolls, etc. The replac-

INSTRUCTION FOR WORKERS IN COTTON MILLS.

ing of the laps on the apron as soon as they run out should be taught. Warn against letting laps run through before renewing and depending too much on the evener motion; also teach the best manner of taking laps off the floor and placing on the apron, to avoid damaging the laps, etc. In teaching to doff the laps, show need of care in taking them from the machine to avoid damaging, thereby decreasing liability of waste. The learner should understand that these laps are doubled on intermediate and finisher pickers to make work more uniform as well as to further remove dirt and seed.

(e) Difficulties; causes for bad work.

The learner should experience little difficulty in the picker room, but should know the reason for any difficulty that may occur and notify the man in charge so that the picker may be fixed and adjusted. He should be able to detect bad laps, uneven or ragged edges, hard or soft laps, laps that may not unwind as they should, also watch for apron sticking, cone belt slipping, or anything which may require the attention of the repair man.

Cleaning and oiling.

In teaching cleaning to a learner, teach the parts to be cleaned (including surfaces), the removal of seeds, waste that may be wound around rolls, and the keeping of the machine free from dirt, etc. The operator should have specified hours in which this work is done, should know just what parts are cleaned at certain hours.

The oiling is usually done by a special operative who has charge of the oiling of shafting and fast moving parts of the machinery, but the oiler should have the parts to be oiled on a list, which may be checked off, thus eliminating much wear due to overlooking some parts which should have been oiled. The operator should notify the oiler of any undue friction in the bearings, as there is liability of fire from overheating.

(g) General care of machine.

The learner should be taught not to leave any metal objects on the aprons or in any places where they will come in contact with rolls, heaters, or gears; to handle the laps carefully, to use care in letting down the racks, and in handling the lap roll.

(h) Factory rules, policies, etc.

The teaching of factory rules will apply to learners in all branches of the industry and concerns their punctuality, absence, quitting, loyalty, cooperation with fellow employees, foreman, and factory, responsibility, enthusiasm, pride in work, and suggestions. The instructor has the opportunity of starting the learner under the right impression as well as giving the policy of the factory, and in a large measure will be able to effect a thorough understanding between employer and employee. Each factory has rules of its own, which are somewhat alike, but they may have a few which are peculiar to their operatives and their policies.

Attention is called to the fact that the substance of the above paragraph applies to learners on each of the machines mentioned in the following pages.

CARDS.

There are two operations which may be taught on cards, and they are card tender or stripper and card grinder. The card grinder is usually chosen from among the strippers and trained for grinding as a helper to the card grinder, but if training is to be given on grinding, the same methods would apply as to the stripper. So the learner on cards usually is the tender or stripper who generally is taught this operation first.

(a) Purpose of machine.

In receiving a learner for stripping, it will become necessary to introduce him to the card and explain its purpose and its relation with other machinery in the factory. The learner should understand that the purpose is to remove dirt, short fibers, and to comb the fibers, to lay the fibers parallel and to reduce the lap to a sliver. Also he should understand the process of combing at the licker and feed plate, cylinder and flats, and how the cylinder removes the fiber from licker, combing and carrying through flats, depositing on doffer, and being removed by the comb, because most of this operation is invisible.

(b) Starting and stopping.

The starting and stopping of machines differ, so it is necessary to teach the peculiarity of each. In starting the card, it is usually the custom to start the cylinder first, the doffer being disengaged as well as the feed, and then engage the drop or barrow gear as soon as the cylinder has attained its speed, watching the web when throwing in the feed and delivery.

(c) Safety.

There is a certain liability of accidents on all machines, although the operative may be protected by having these places cased in. The protection may be removed, the machine started, causing an accident, so it is important that these causes of accidents be explained to the learner. He should be warned against coming in contact with moving belts because of clamps, lacing, or rough edges, also the possible danger of gears, although they may be partly cased in. He should be warned to never let down the door to the front plate while the card cylinder is in motion, and to keep hands away from teeth of doffer comb and any other sharp points which may be exposed.

(d) Operations.

1. The first operation usually is putting on laps, and in teaching it the best method in handling the laps is essential, likewise the best way of taking down the lap from the stand, and handling it with least effort and most quickly. Care must be taken in piecing full lap, to break off the fringe or smooth it out and place the end of full lap on tail end of lap that is running out. Warn learner never to let tail end run through card because that damages the fine teeth of the cylinder and doffer clothing.

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2. The piecing up of the web should be taught, the best way to do it to make least waste, and the manner of passing through the trumpet between calender rolls to top of coiler, through tube gear, and into can at the coiler.

3. The learner should be able to doff the full cans in minimum time, taking care not to spill them. In replacing empty cans, he should see that the sliver has been removed and that the cans are entirely empty.

4. Perhaps the most difficult operation for the stripper to learn will be operating the stripping brush. This brush is usually operated by two operatives, the more experienced stripper operating the bands—one who usually has acquired the knack while assisting some more experienced stripper. The learner should be taught how to place the brush on the stands, to put on the band, just how to start the cylinder, how to turn out the gear for the feed roll and delivery rolls, how to remove the strippings from the brush, and how to start the cylinder and doffer, etc. (Note: Nowadays there are stripping devices on the market while one operative may operate and strip the cards, the device being largely mechanical and attached to card.)

(e) Difficulties, causes for bad work.

The learner should be taught what constitutes bad work, how to detect thin and thick places in the web, to notice if the web is rough and uneven, if it follows the doffer or sags, if it sticks to the comb, if the sliver sticks in the coiler at the rolls or top of tube gear. Some of these things may be remedied by the stripper while others necessitate calling the card grinder, the main point being that the stripper should know bad work, so as to call the grinder's attention to it when necessary.

(f) Cleaning and oiling.

The cleaning is usually done after the stripping, the tender doing this in conjunction with his other work. The learner should be taught what parts to clean, how it is done, the time for cleaning, and how to avoid the parts where the cleaning material may get caught. The removal of the fly and cleaning of surfaces is usually done at specified time.

The oiling on a card is usually done by a special operative or the card grinder. It is quite important that the parts to be oiled and the time for oiling be listed according to a schedule so that the work can be checked at times to avoid having parts go dry because of oversight.

(g) General care of the machine.

In teaching the general care of the card, the learner is told not to leave metal parts on the lap, and is warned against metal objects coming in contact with the wire surfaces of the cylinder and doffer; the brush or cleaning material must not get caught in the gears or rolls while cleaning, etc.

CARD GRINDING.

The card grinder is usually selected from among the strippers, and already has knowledge of the card, its working parts, and the quality of its work. Therefore, in teaching a card grinder, it will be necessary to teach the grinding of the surfaces, the setting of the different parts, etc.

The card grinder, should know all the operations and how to perform them correctly. Teach him how to prepare his card for grinding, to cut out feed, to remove lap, strip cylinder and doffer, run card until flats have been stripped, strip cylinder and doffer again, clean card thoroughly, remove belts and bands, reverse driving belt, and to put on the belts and bands for grinding, starting, and brushing out cylinder and doffer, then stopping and putting grinding rolls in stands, and to turn rolls by hand or thin gauge inserted between rolls and surface to be ground, so that they will be clear before starting the card. The card is then started slowly and the setting of the grinding rolls begun. The experienced operator usually listens at each side of doffer and cylinder. The learner is taught how to bring the rolls nearer the surface, etc. The amount of grinding is determined by the sound, the length of grinding depending on the condition of the wire and the amount of grinding. After grinding, the rolls are removed, the cylinder and doffer brushed out to remove pieces of steel or emery that may be in the wire, the belts and bands used for grinding removed and the other belts replaced.

At this time the adjustments or settings are made. These are due to the wear of journals and shafts or to the wear of the surfaces because of the grinding. The learner or grinder should know of all the places where settings are required, how to make the necessary adjustments and to use the proper gauges.

The grinder should have a list of the different places where setting is done, the amount of setting in each place, so that none may be overlooked during the regular performance of duty, for example:

Licker and cylinder..	Size of gauge.
Doffer and cylinder..	Size of gauge.
Flats and cylinder...	Whether graduated setting or not, and amount at each point.
Feed plate.....	Size of gauge.
Cylinder screens.....	Size of gauge.
Licker screen.....	Size of gauge.
Back knife plate....	Size of gauge.
Front knife plate....	Size of gauge.
Doffer comb.....	Size of gauge.
Mote knives, etc.....	Size of gauge.

The purpose is to list all the different settings and the amount, so a record of same can be kept. Besides knowing how to prepare and grind his card and how to make all the adjustments, the card grinder must know how to make the necessary repairs, how to splice bands, to see that the quality of work is the best, that the cards are producing the amount of work they should, and that they are stopped for stripping, grinding, etc., as little as possible. He also has charge of the oiling and should see that all the bearings are properly oiled and greased and that the comb box has sufficient oil. The card grinder usually has supervision over the strippers and should be responsible for the condition of the cards.

DRAWING FRAMES.

(a) Purpose of drawing frame.

The purpose of the drawing frame is to lay the fibers parallel to each other, to correct any unevenness in the sliver, and to reduce from six to eight slivers at the back of the frame into one at the front. This is accomplished by passing the slivers through four pairs of rolls, each succeeding pair going faster than the preceding one, thereby pulling the fibers past each other as well as reducing the weight into one sliver.

(b) Starting and stopping.

The starting of the drawing frame consists of shipping the belt from loose pulley to tight pulley. As the frames are arranged with an automatic stop, when a sliver at the back breaks or runs out, or if the end at the front breaks, it is necessary only to observe if any ends are broken before starting. In stopping the frames for the week end or for any period longer than over night it is customary to release the weight on the rolls and in starting the frame to let down the weights.

(c) Safety.

The learner should be taught to avoid getting any metal parts or tools or cleaning material caught between the rolls, not to remove gear casings while the frame is in operation or if any have been removed not to start the frame until they are replaced. When cleaning around gears, etc., it is best to remove driving belt of frame and to avoid getting material caught around shafting or on a belt.

(d) Operations.

1. The renewing of slivers consists in taking the end of sliver from the full can, placing it on the tail end of the sliver that is to pass through the rolls and starting the frame, catching end of new sliver between back rolls.

2. Piecing up the sliver at the front should be taught—passing the end through the trumpet, catching between the calender rolls and passing through the coiler tube, and then splicing the sliver in the coiler can. Also teach the best way to make the splice.

3. In doffing the full cans care should be taken not to spill the sliver thus making unnecessary waste, and to doff the cans when the frame has been stopped because of the full can stop motion.

(e) Difficulties and causes for bad work.

There is a tendency to throw the end when renewing the sliver, which is bad practice, because the end is not pieced in as it should be. The learner should be warned against letting ends run through before renewing and against making long splices. He should watch for bad rolls, if they are leather covered, as they will make uneven sliver.

(f) Cleaning and oiling.

The learner should know the parts to be cleaned and the time they are to be cleaned. He should be taught to keep the clearers clean from waste, because if it accumulates it will pass in with the good

cotton. When wiping the frame it should be stopped. In cleaning the under portion he should be careful not to catch cleaning material around the shaft.

There are certain parts of the frame that are oiled by the drawing frame tender; other parts are usually oiled by a special operative. The former are usually oiled every day and the learner should know just which parts they are and should wipe off all excess oil.

(g) General care of frame.

Operative should be warned not to use knife or other hard metal in removing cotton that may wrap around the rolls and should be careful not to injure the rolls as this will cause bad work and increase the liability of sliver wrapping around the rolls. Be careful in handling rolls and tube gear when removing cotton that may jam between the calendar rolls and tube gear.

COMBING MACHINERY.

In those mills which have combing machinery it will be necessary to train learner on the same so they will understand their purpose, the quality of work which is produced, etc. The usual machines connected with combing will be the sliver lap machine, the ribbon lap machine, and the comber. The purpose of this machinery is to take the ordinary card sliver and remove all short fibers not of a certain length and form another sliver in which the fibers are practically the same length.

SLIVER LAP MACHINE.

(a) Purpose of sliver lap machine.

The purpose of sliver lap machine is to form a lap from slivers that are produced at the card, this lap to be used on the ribbon lap machine. This will be quite apparent to the learner if the machines are near each other. Teach the necessity of making as perfect laps as possible.

(b) Starting and stopping.

When starting the sliver lap machine, before shipping the belt from loose pulley to the tight one, see if any ends are broken or need renewing, and that disks are tight and screwed up to the side of the lap. This disk sometimes becomes loose when suddenly stopping the machine. The stopping requires no special skill. However, when stopping at noon or night remove full laps; when there is no lap left in the machine it will be easier to start in the morning.

(c) Safety.

The sources of danger are similar to those of the drawing frame. The learner should be warned against coming in contact with moving belts and getting clothing or cleaning material caught between the drawing or calender rolls, and to be careful of the gears.

(d) Operations.

1. The first operation usually is that of renewing slivers at the back, it being similar to that on the drawing frames. A stop motion operates when the sliver breaks or runs out and then the learner

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renews it so that the end of new sliver will be placed on tail end of other sliver, after which the machine is started again. The operator should be careful not to let ends run through before renewing because this makes weak places.

2. The ends pass over the table and through three pairs of rolls which have a slight draft and through heavy calender rolls, form a lap at the front, where the operation consists of removing full laps and replacing spool to form a new lap. In teaching the learner to remove full lap and replace empty spool or roll, the best method should be taught, namely, to make it a continuous movement in loosening the disk, drawing out the shaft and taking out the lap, thus saving time.

(e) Difficulties, causes for bad work.

The operative must watch for ends running through, and, if there is an electric stop motion, see that it is always working. In forming new laps see that the disks are tight, so as to make smooth sides on the lap; see that the full lap stop motion is working.

(f) Cleaning and oiling.

The surfaces are usually cleaned twice a day, and the table and rolls kept polished and smooth. Be careful in cleaning not to get cleaning material caught between rolls and gears. The machine should be stopped when being cleaned. There is not much oiling to be done on the sliver lap machine and it is usually done by a special operative who oils other machinery also.

(g) General care of machine.

Teach the learner to be careful in letting down the racks when making a new lap, so that they will not come down with a thud. He should be careful about leaving metals on the table, etc.

RIBBON LAP MACHINE.

(a) Purpose of machine.

The ribbon lap machine will differ somewhat from the sliver lap although its purpose is to make a lap for the comber. The four or six laps being drawn between sets of drawing rolls, over polished plates, and over a table form the lap for the comber. Impress the learner on this machine with the importance of making good laps.

(b) Starting and stopping.

In starting the ribbon-lap machine, the learner should make sure that the drawing rolls are weighted, that there are laps at the back and that the disks are tight. The plates and table should be clean and polished so the sheet of cotton will not stick or bunch up and make bad laps.

(c) Safety.

Here also the dangers of getting parts of clothing or cleaning material caught between the rolls or in the gears, and the need of avoiding moving belt should be explained.

(d) Operations.

1. The first operation usually is creeling or renewing the laps at the back. When removing the laps take care in making good piecings, that the end of the new lap be placed on the tail end of that which is running out so that it will not bunch up or make thin places when starting the machine, because a thin sheet of cotton passing over the polished plate is liable to bunch on the table, making uneven lap.

2. The method of removing full laps is similar to the same operation on the sliver-lap machine, the object being to make a perfect lap, if possible.

(e) Difficulties, causes of bad work, etc.

The operator must watch for laps sticking or bunching up when passing over the polished plates as there are no stop motions at this part of the machine, hence, it requires the constant attention of the operative. He should see that full lap and back-stop motions are working.

(f) Cleaning and oiling.

Teach the learner to remove the waste which is constantly accumulating, from the cleaners, to keep plates and table polished, to keep the rolls free from dirt and to wipe off the dirt and dust from the surfaces.

The oiling is usually done by the operative who oils the sliver-lap machine. There should be no excess oil left on any parts of the machine otherwise dirt and dust will gather on these parts.

(g) Care of machine.

The operator must be careful that no hard metals come in contact with the rolls or the polished plates, that these plates are always in good condition. In forming a new lap he should be careful in letting down the racks and tightening the disks. The best quality laps should be made on the ribbon-lap machine.

COMBERS.**(a) Purpose of machine.**

The learner should understand that the comber removes the short fibers, and changes the form of lap back into a sliver, the short fibers having been removed and deposited into cans or the like.

(b) Starting and stopping.

It is best to polish the plates and to be sure the rolls are weighted before starting the comber. Then ship the belt from loose to tight pulley. The stopping of the comber is done merely by shipping the belt.

(c) Safety.

The dangers for an operative are relatively few. Teach him to avoid catching part of cleaning material between the drawing rolls and coming in contact with the sharp points of the combs, half lap, etc.; when cleaning let him guard against accidentally starting the machine, especially when cleaning the half lap or removing waste that may have been caught.

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(d) Operations.

1. The laps are placed on top of the creels and ready for use, and the learner should be taught the best method in handling the laps when renewing so there will be no bunching between the top comb and nipper knife. The laps *must not* run through the comber, because that will break out of needles in the top comb and half lap.

2. Another operation is that of piecing up at the pans when an end breaks and piecing up at the head end of the machine or draw box, through trumpet and into the can at the coiler. In piecing up, the learner should be careful of thin places caused by singles or of thick places caused by the end doubling on the table. The cans are removed when full and replaced with empty ones.

(e) Difficulties, etc.

The chief difficulties are caused by the cotton bunching between the top comb and nipper knife, which usually results from thick places in the lap or when renewing laps. Another difficulty results from slivers doubling along the table, necessitating the polishing of the table with whiting or similar material. The drawing rolls, coiler, and other surfaces over which the cotton passes should be kept polished. Because of the quality of work which the comber is designed for, it is necessary that the tender be careful to see that all parts are working as they should, calling the attention of fixer to need of adjustment, etc.

(f) Cleaning and oiling.

It is necessary that the comber be kept as free as possible from dirt and dust, so that the waste or lint will not pass with the good cotton, and that the learner be taught to clean the surfaces and rolls at certain hours.

Some parts of the comber may be oiled by a special operative who has charge of oiling other machinery in the room, while other parts will be oiled by the comber tender. The hours of oiling should be listed so that a check can be kept on this work.

(g) General care of machine.

The learner should be taught to handle the parts of comber carefully, such as combs, half laps, rolls, as it is important that these parts be in good condition. He should be careful not to damage the polished surfaces with hard metals and should notify repair man when stop motions are not working properly.

FLY FRAMES.

The principles of the operation of the slubber and the intermediate or roving frame are the same, except that the slubber reduces the sliver into roving, while the other frames reduce two strands of roving into one. In teaching a learner for fly frames, adaptation will depend to some extent on physical strength, because the slubber is so much heavier work than the roving or jack frame.

(a) Purpose of frames.

In introducing the learner to a fly frame, it should be explained that its function is to reduce the sliver or doublings into one strand

at the front by drawing rolls, to even the product by the doublings, to parallelize the fibers, to insert sufficient twist to hold in the creels of the next machine, and to wind on bobbins. Its relation to other machinery in the factory should be explained as well as the necessity for proper quality in the product.

(b) Starting and stopping.

The starting of fly frames begins with shipping the belt from the loose pulley to the tight one. This must be done gradually so that the cone belt will not slip; if it should slip, it would be likely to let the ends down at the front. Also, if the frame is started suddenly, it will have a tendency to strip gears at end of bobbin rail.

The learner should be taught not to stop the frame exactly on the change of traverse because of the liability of gear on tumbling shaft being out of adjustment, but to stop it either before or after a change. Also point out the stop motion for full bobbins and explain why they are provided.

(c) Safety.

Do not clean the fly frames while the machine is in operation; the cleaning materials are liable to get caught in the swing gears, the gears for the traverse motion, and others partly exposed. The learner should be warned against getting his hand caught between revolving flyers or gears.

(d) Operations.

1. The creeling on the slubber will consist of renewing the sliver at the back, and is usually done just before the cans are empty. The operator takes the end of the sliver from the full can, breaking off the sliver at the slubber and places the end of the new sliver on the tail end of the sliver which is about to pass through the rolls, so it will catch and not break down at the front. The creeling on intermediates and roving frames is done by replacing empty bobbins with full ones. There should be full bobbins on top of the creel. The pupil should learn how to break off the strand of the bobbin that is nearly run out, take a full bobbin on the skewer, then find the end and twist on the end which has been broken off, then place bobbin in creel. In creeling on intermediates and roving frames, it is best to alternate full and half-full bobbins, so they will not run out together.

2. In piecing up at the flyers, teach the learner to remove waste or broken end; to unwind sufficient length from bobbin to pass through leg of flyer; how to wrap the number of turns around presser; to pass through hole in top of flyer and to twist at the rolls. Start frame slowly to lessen liability of stretching splices.

3. *Doffing*.—The learner should be taught the necessary movements in doffing and the best method in performing them. The operative should have bobbins and a box ready before the doff is full to save time that might be spent in looking for these later. The following distinct operations must be taught when doffing:

- (a) Raising cone by winding, letting down ends by starting frame a little.
- (b) Removing flyers for doffing. (Some operators do not remove any flyers on large frames while others remove the front row on both coarse and fine work.)
- (c) Removing the full bobbins and replacing with empty ones.

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- (d) Replacing the flyers and attach ends to empty bobbins by crossing and coiling end.
- (e) Shifting cone belt to starting position and letting down cone.
- (f) See that bobbins and flyers are well down in place before starting frame, and then to start slowly as some ends may not catch or be wound on the bobbin.

(e) Difficulties, etc.

Learner should understand the action of the cone belt, the shifting as each layer of roving is wound on bobbin, the action of traverse; he should avoid stopping frame on change and moving the cone belt by hand when the ends are running loose or tight. In such an event he should call section hand. Special attention should be given to singles and doubles and to removing them when piecing up. Keep a lookout for soft bobbins, also bobbins not being down in place causing running over or under, and avoid hard twists when piecing up.

(f) Cleaning and oiling.

The learner should be warned not to clean while the frame is in operation, especially in the region of the gears. He should be taught to clean the roller beam, creels, rails, framework, etc., and to keep spindles and flyers wiped and free from lint. It is necessary to keep the waste from accumulating on the clearers so that it will not pass in with the good cotton. The spindles should be oiled so the rail may traverse up and down easily, this oiling being done usually after the first doff of the day. The top rolls are oiled every day, or as may be directed by the foreman. Most of the oiling on fly frames is done by a special operative, who oils several other frames, but the parts that are to be oiled should be listed and the time of oiling noted, so that no parts are overlooked.

(g) Care of the machine.

Explain the ways in which a frame is apt to be damaged and how to avoid unnecessary breakage, such as results from getting a broom caught in gears when sweeping, or getting cleaning material or bobbin caught between flyers while in motion. Avoid leaving material where it is likely to be swept into gears or moving parts. Avoid rough handling of parts.

RING SPINNING.

(a) Purpose of frames.

The learner on the spinning frame should be taught that its purpose is to give the final drawing and twisting to the cotton making the yarn. Heretofore the learners have been instructed regarding the quality of production, the reason being that the best quality of yarn is essential to the success of the plant. In introducing the spinner to the frame, explain that the roving is drawn through the rolls and is given twist by the revolving of the spindle and traveler.

(b) Starting and stopping.

The spinning frame is usually started by the section hand, who starts several frames, being assisted by other special operatives. The frames are in operation continually unless stopped for doffing or cleaning the separators and ring rail or repairing.

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(c) Safety.

The learner should be warned against removing gear casings while the frame is in operation, and against catching part of clothing or the hand between the teeth of the gears. Teach him to avoid coming in contact with moving belts or placing his hands between spindle bands or tape and spindles.

(d) Operations.

1. The first operation usually is creeling. The learner is taught how to remove the bobbin when nearly empty, how to break off the end, to take full bobbin on skewer, to find end and twist on the end that is to pass through the rolls, being careful not to make long splices, and then to place full bobbin in the creel.

2. *Piecing up.*—In piecing up the learner should be taught the best way to remove the bobbin from the spindle, to grasp the bobbin with an upward movement, to find the end and catch yarn under the traveler, to replace bobbin on spindle, to pass thread through guide, and to piece up at the rolls. There are several best methods of piecing up at the rolls, depending somewhat on the counts yarn being spun, the shape of fingers and thumb, etc. Some operatives piece up by twisting the yarn, others by letting the yarn pass over the tip of the forefinger of the right hand. These operations may also be done with the left hand. The object is to make a good piecing without bunches in the yarn.

3. *Doffing.*—The doffing on the ring frame is usually done by special operatives who are experienced spinners, but it may be necessary to train a learner to doff. List the different operations and how they should be performed. The learner should know about:

- (a) Pushing down the rail; fastening rail and shipping belt; giving the ends slackness; turning back these separators; winding builder motion back.
- (b) How to remove the full bobbins and replace with empty ones.
- (c) To turn up the separators; to start the frame after doffing easing up on the rail; shipping belt, etc.
- (d) How to piece up ends after doffing, by holding bobbin under chin or other methods; running of the yarn on the empty bobbin; passing end under traveler and through guide and then to piece up at the rolls. (This will take some time for a new hand, but a spinner will have picked up most of these operations while performing the necessary duties on spinning.)

(e) Difficulties and causes for bad work.

Learner should be taught the importance of getting best quality of work and to avoid making singles or doubles; to remove, or have section hand remove bad rolls; to put on travelers when they may fly off; to notify section hand of undue vibration of spindles, loose bands, etc., which will cause soft bobbins; to break off loose bands; if an end breaks repeatedly to watch for bad rolls or for a spindle out of center.

(f) Cleaning and oiling.

When cleaning the frame, to be careful that waste or lint does not pass in and become twisted with the yarn; to remove lint from the creels, rails, and framework, etc. When cleaning ring rail and separators, the frame is usually stopped so the lint will not be twisted in with the yarn. After an end breaks and is pieced up, remove the roll waste from the scavenger rolls, being careful not to let it pass in with

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the yarn; keep it separated from other waste because it is good cotton. The oiling on the ring frame is usually done by a special operative who oils the spindles, cylinder bearings, rolls, etc., but the spinner should know when parts of the frame are dry.

(g) Care of machine.

Warn learner not to grasp bobbin with a sideward pull when piecing up, because of liability of forcing the spindle out of center. Teach him to keep waste or hard materials from passing through the drawing rolls; to watch for roving winding around the rolls, and not to use knife in removing the cotton from the rolls; to keep the clearers from accumulating too much waste, so that it will not pass between the rolls and break ends.

COTTON MULES.

(a) Purpose of machine.

The purpose of the mules is similar to that of the ring frame, namely making yarn from roving, although the machines are quite different in construction. The two strands of roving in the creels are drawn into one strand at the front, as in the ring frame, but the delivery of the front roll on the ring frame is constant while that of the mule is intermittent, and that instead of winding on bobbins, the yarn is wound on tubes, making cops.

(b) Starting and stopping.

To teach the starting and stopping of cotton mules necessitates explaining the different working parts of the mule. The belt is not always on the tight pulley when the frame is in operation and inasmuch as the cotton mule is so much more difficult to learn than the ring frame, it will probably require a longer training.

(c) Safety.

The headstock which contains most of the gears and working parts of the mule is usually inclosed by wire casing or some other protective barricade to shield the operative. The operative should avoid slipping on floor or tripping over rope, etc., in front of carriage which runs in and out from the frame.

(d) Operations.

The actual operations on the mules are few and comparatively simple, and are quite similar to those of the ring frame. The creeling is usually done by a back boy who replaces the empty bobbins in the creel with full ones, but should have the same care in piecing as on ring frames, to avoid making long splices and letting singles pass through.

The piecing up of ends at the rolls is similar to that on the ring frame, but may need a little more attention because the piecing is done when the carriage is nearest the rolls and just pulling away or starting to run out. In teaching, emphasize accuracy and speed in making piecings, as it is necessary to keep out of the path of the carriage. The piecing is usually done by twisting.

The doffing of the frame may be done by the spinner or a special operative, but the person or persons who doff must know the actions of the different parts, such as the fallers, builder, quadrant. When stopping the frame for doffing they must know how to adjust the fallers, the quadrant, and builder, and when starting the frame after doffing these parts will be in the correct position for making a new cop. Stop by shipping counter belt from tight to loose pulley just as carriage completes outward run and when the winding faller has completed downward movement. The learner should slacken spirals of binding layers, depress fallers, hold them down by inserting block of wood, turn quadrant screw, and slacken winding chain as traveler is reset. Next reset builder motion so shoes will be in first position. Then ship belt to let carriage in about 3 inches and after removing cops and setting tubes, remove block, easing up on counter faller, set drawing-in friction, etc. It usually requires services of two operatives assisting each other when doffing.

(e) Difficulties, etc.

Because of the quality of yarn that is usually produced on mules it will be necessary for the spinner to use care in making the yarn to be able to detect uneven yarn which may be caused by uneven fiber, uneven roving or too much twist in the roving. Change rolls when worn and make good cops. The principles of making good yarn that apply to the ring frame also apply to the mule.

(f) Cleaning and oiling.

As is in the case of all machinery in the textile industry, the dust or fly should not be left to accumulate but should be wiped off at certain periods, care being taken that it is not twisted in with the yarn. Most of the parts on the mule will be cleaned by special operatives, but, whatever method is used, it is important that as perfect yarn as possible be made.

The oiling on the mule usually is the duty of a special operative, but it is imperative that no parts go dry. As much of the wear of machinery is due to lack of oil at the proper time, the different parts to be oiled should be listed so that a record can be kept of the care in this respect.

(g) General care of machine.

The spinner should know just when the machine is not working properly and notify the repair man. The same general rules apply to the mule as to other machines.

Let the spinner be careful that spindles are not bent, that rolls are not damaged, and other parts are kept in good condition.

TWISTERS.

(a) Purpose of machine.

The learner should understand that the purpose of the twister is to twist two or more strands of yarn into one, making ply yarns for special purposes.

(b) Starting and stopping.

Starting and stopping the twister is quite simple. It involves shipping the belt from loose pulley to tight one. After the frame

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has been started, the operator should go around and see that all strands are in operation and that no stop-motions are caught, that there are no broken strands from spools on creel. The frame is stopped by shipping the belt.

(c) Safety.

Here, as on all machines, the learner should be warned of possible dangers of gears, moving belts, etc. Warn him especially of the heavy traveler which may have sharp edges and is liable to cut the fingers if placed in its path.

(d) Operations.

The creeling may be with spools or with bobbins. Its purpose is similar to the creeling on all machines, namely, the replacing of full spools or bobbins when nearly empty. Care should be taken in tying small knots.

Piecing up necessitates the stopping of the spool by the brake, finding the end and tying small knots. Make as little waste as possible.

After the spools or bobbins are full, the frame is stopped and doffed. It is usually stopped when the rail is low; the spools are removed and the strand broken and replaced by an empty spool and the end is wound on this empty spool.

(e) Difficulties, etc.

An operator must watch the tying of the knots when ends are broken in the creel and must watch for these ends, especially where the yarn is more than two ply. In case of loose bands, which will make soft spools or bobbins, he should break them off or notify the repair man, who replaces them; must see that correct counts yarn is being twisted.

(f) Cleaning and oiling.

Teach the learner how to clean and wipe down the creels, roll beam, ring rail, framework, and surfaces.

The oiling is usually done by a special operative, who oils the pulleys, cylinder bearings, rolls, spindles, etc. This work should be checked, to see that no parts are overlooked.

(g) Care to be taken.

The operator must keep watch of the making of spools, the working of the stop motion, and where yarn is more than two ply he must watch for ends broken in creel, as stop motions will not be working.

SPOOLER.

(a) Purpose.

Teach learner that the purpose of the spooler is to assemble a greater length of yarn by winding and tying together the yarn from several bobbins from spinning frame and get this yarn in shape for next process.

(b) Starting and stopping.

The starting and stopping is done by shipping belt from loose to tight pulley. The frame usually is in constant operation during the day.

(c) Safety.

There are few dangers on the spooler, but the learner should be careful of gears, belts, and bands that drive the spindles, and use care in stopping the spools for tying knots.

(d) Operations.

The learner should be taught best method of placing bobbin in holder and finding end, passing it under swinging wire and through thread guide, this being done in one operation. Then, how to stop spool, to find the end and bring the ends from the bobbin and from the spool to the knot-tying machine, which the operative manipulates with left hand. Teach the easiest and quickest method of finding these two ends and bringing them together at knotting machine, likewise the easiest method of tying the knot.

(e) Difficulties.

In stopping spools to tie end, the learner should be careful not to squeeze yarn so strands will be turned under others, which will be likely to break when unwinding. He should watch for ends flying over to next spool, causing doubles; make small hard knot; use correctly marked spool for yarn that is being used, and remove all yarn from bobbins before sending them back to spinning room. (Singles in yarn are usually sent back to the spinning room so the work can be checked up.)

(f) Cleaning and oiling.

The cleaning of surfaces, etc., is performed as on other machines in the factory. Use care to prevent cleaning material being caught in moving parts. The oiling often is done by a special operative, who oils the bearings and spindles and who usually replaces bands when broken or worn.

(g) General care of machine.

Teach learner to use care in handling the various parts, such as bobbin holder, thread guide, and not to be careless in usage of knot-tying machine, etc.

WARPING.**(a) Different kinds of warping.**

There are several different makes of warping machines, such as beam warping and chain warping. The purpose of beam warping is to wind yarn from a large number of spools which are placed in creels into an even sheet on a beam. In chain warping the purpose is to form these ends in ^{several} loose untwisted rope of yarn. The rope of yarn may be in several ^{forms}—circular chain, ball chain, or link chain.

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(b) Starting and stopping.

The starting of all warpers is practically the same. Slip the belt from loose pulley to slow motion and then to tight pulley. Instruct learner to speed up the spools gradually, so that the yarn will not come under sudden strain. When stopping the frame reduce the speed gradually, even though there is a drop or rise roll which takes up the slack.

(c) Safety.

There is relatively little danger in working. The operative should be careful to avoid belt clamps, gears, and getting clothing caught in rolls or cones.

(d) Operations.

The creeling on all types of warpers is practically the same. It consists of placing full spools in the V-shape creels. This is usually performed by special operatives, but whoever is assigned to this work should make small hard knots when tying full spools to the end of the one nearly empty.

Some creels are larger than others, depending on work that is produced. On some warpers the ends pass through combs, dents in reed, some through eye board, each end passing through an individual eye. When an end breaks the stop motion which is on each frame allows for stopping of frame so the end may be tied. The learner should know when and how the frame is stopped for broken ends and should understand the rise or drop roll which takes up the slack. On beam warping the learner should be taught how to adjust comb to width of beam. On chain warping it will be necessary to insert leases at different lengths; to do this it will be necessary to raise part of the ends so lease may be passed between the strands. On some warpers alternate ends may be raised to allow this. On Denn warpers each alternate end or number designated is passed through harness eye, other end between heddles, those in harness eye raised and lease inserted. Doffing is performed by special operative.

(e) Difficulties caused by bad work.

In tying ends, teach the learner to get right end and the necessity for small hard knots.

(f) Cleaning and oiling.

Clean periodically, removing waste, etc., as on other machines. Emphasize necessity of oiling as on other machines.

SLASHERS.

(a) Purpose of slasher.

Explain to the learner that the slasher is used to coat the yarn with starch so that when going through the weaving process the threads will not be worn, frayed, and broken by the action of the reed and harnesses. Explain that a number of beams which have many ends or threads of yarn are assembled at the back of the slasher to form a warp at the front which is to be used in the weaving. The yarn is starched as it passes from beams in creel and is dried before it is wound on the warp beam.

(b) Starting and stopping.

The slasher is started by shipping of the belt from loose pulley to the tight one, this being done gradually. A slow-motion pulley is used frequently when it is desired to run the slasher slowly during the operation. Before the slasher is started in the morning it is necessary to obtain a certain steam pressure by opening the outlet valve, letting out the cold air and closing it when the cylinder is hot. If the size is left in the vats overnight, it will be necessary to remove the skim and boil the size. When hot, let the squeeze roll down and start the slasher until the yarn has been run up to the front, then remove the dirty yarn and tie the ends to the warp beam. The machine is then ready to start. To stop the slasher, ship the belt from the tight pulley to slow motion and then to the loose pulley. But, as in starting, it is necessary to bear in mind facts mentioned above, especially if stopping the machine overnight. It may be that the set is run out at night before stopping, but if it is left partly run out it will be necessary to stop the machine at the cut mark, so as to make little yarn waste. It is necessary to raise the squeeze rolls and place them on the stands and raise the dip or immersion roll at noon and night. Many of these features can be brought out when explaining stopping and starting the slasher.

(c) Safety.

The operative must be careful not to place his hands near the bite of the heavy rolls at the back or the rolls at the front. Tell him to be careful of the gears and belts and be careful in lifting the rolls when placing them on the stands, because of their weight. Warn him against cleaning the slasher while in motion. This is not usually done because of the attention which must be given to the slasher while it is in motion.

(d) Operations.

There are several different operations that must be taught to the learner when operating a slasher:

- (a) Placing beams in the creels.
- (b) Tying ends to the end of yarn which has run out.
- (c) Letting the squeeze rolls down.
- (d) Have enough size in vat to size the yarn.
- (e) Running the yarn through the rolls.
- (f) Put in leases, to run them up to beam nearest size vat.
- (g) Making the tape with striking comb, placing center of comb at center of yarn.
- (h) Running tape about 3 feet, striking cut mark.

The yarn is then run around the cylinder slowly until the knots are near the splitting bars at the front, then the machine is stopped, the bars removed, the reed turned down, and the yarn run until the lease strings and comb are brought forward, the center of the comb to the center of the reed, the reed turned up and the tapes laid in. The lease or split rods are inserted and placed on the stands. The tapes may be laid beginning at the center or at the ends, but if the comb and reed have the same number of teeth, the tape may be laid, starting at the end. The learner should understand that the purpose of laying of the tape is to have the strands of yarn evenly divided into the dents of the reed. On some work this may be done by striking with the comb, while on other work the ends

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have to be counted in. When forming a new warp, the friction should not be too tight, but should increase as the yarn is wound on the warp beam. In some factories it is necessary to put in lease strings when making each warp. These should be put in near the cut mark so that if they make any marks in the warp the marks may be removed in the weave room.

(e) Difficulties, etc.

Learner must watch for laps on the beams which cause missing ends in the warp and will necessitate using spools in the weave room. He must not have cut-mark dye too heavy as it will spot yarn and spoil cloth. He should stop slasher on cut mark overnight so if there is a bad place in the yarn because of stopping, it may be removed. He must not run the frame too fast but have the yarn dry perfectly, as yarn that is run wet will harden and can not be woven. Have him keep press roll smooth at each end or it will cut the selvage, causing bad work in weave room. There must be good jackets on squeeze roll, as these jackets are usually made of wool cloth, this cloth being replaced when worn off in bad shape, and the learner must know how to replace this jacket. He must keep immersion roll well down on certain kinds of work, while with others this is not necessary. He must not let size get too low in size vat as this will make dry roll and yarn will not weave and will have to be removed when the mistake is found in the weave room. He must also keep expansion comb adjusted so yarn will be wound evenly on beam.

(f) Cleaning and oiling.

As with other machines in the textile mill, the slasher must be kept free from dirt, lint, or waste, so it will not pass in with the work, but the learner must know of the danger of cleaning while the machine is in operation. He should not neglect any duty for cleaning. The parts to be oiled should be taught, and he should learn not to use too much oil, as it will spatter and make black spots in the cloth.

(g) General care of the machine.

It is the custom of some mills to remove the size from the vats every night while others remove it at the end of the week. Learner should remove the squeeze rolls every night and place in stands. He must not let the squeeze rolls down violently on the copper rolls as it will dent and make wet spots on the yarn. Dip or immersion roll should be raised at noon and night.

WEAVING.

The purpose of the weaving department is to produce woven fabric or cloth by means of a loom.

There are several types of looms making different styles of cloth, among which are plain looms, automatic looms, fancy or Dobby looms and Jacquards. There are also arrangements for special cloth.

The purpose of all looms is to interlace warp yarn and filling yarn making the desired fabric or cloth.

The operations on the loom consist of tying knots or piecing up broken ends, drawing through harness eyes, through dent in reed, replenishing filling, finding correct pick, adjusting pattern chain or card (on fancy and automatic looms) and picking out. Before a learner is fully qualified it will be necessary to understand the various motions of the looms and what they are for. On the plain loom the motions are:

- The picking motion.
- The beating-up motion.
- The harness motion.
- The let-off motion.
- The take-up motion.
- The filling-stop motion.

The learner should understand that the picking motion is produced by cam point striking picking ball, which snaps the picking forward, driving the shuttle which carries a bobbin of filling from one shuttle box to the shuttle box at the opposite end of the lay. Explain that the shuttle remains in the box because of binders which hold it from bouncing out.

This necessitates explaining the harness motion to the learner. As the shuttle passes from one box to the other, it passes between two layers of yarn called shed, and lays one pick of filling. This shed on plain looms is caused by one harness being up and one down and is worked by cams and levers underneath the loom and by rolls and springs on the arch of the loom. As the cams revolve it pulls one harness down and lets one up, the shuttle, passing through this shed, lays one pick of filling and the crank shaft in turning will beat this pick to the front, or fell, of the cloth and by its continuing will open the shed again so another pick may be laid from shuttle in the other end of lay.

This motion of the reed as it comes to the front after each pick is called beating up.

The learner should also understand the let-off motion, which may be mechanical or frictional, the purpose being to hold the warp beam, but as each pick is put into the cloth it will be necessary to permit the warp yarn to move forward and still keep enough tension on the yarn.

As each pick is placed in the cloth it will also be necessary to take up the cloth as it is woven. This take-up motion which results from a combination of gears at the front of the loom, causes a roll with rough surface to grip the cloth which is wound on the cloth roll. An explanation of these various motions to a learner will give a general idea of the purpose of the loom and its operation.

Another motion which the learner should understand is the filling stop motion, produced by a fork attached to a slide, the prongs of fork entering a grate. The filling acting on the fork raises the end while there is filling in the shuttle. If the filling runs out, there will be nothing to raise the end of the fork and the end will connect with a cam follower, moving the slide forward and pressing against a lever. This causes the shipper handle to disconnect or slip out of notch, thereby stopping the loom. This allows replenishing of filling.

The learner should understand the preparation of the loom for weaving. Assuming that the parts of loom and motions have been adjusted and the loom put into condition for weaving, the warp is

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then placed in the loom at the back. The warp yarn with reed and harnesses are passed over the whip roll, the harnesses hooked to straps extending from harness roll on top of loom, the bottom of reed placed in groove in lay of the loom, the top of reed held by pressing down reed cap and fastening. The bottom of the harnesses are then hooked to jacks and levers which are operated by cams, the lay brought to front until crank shaft is bottom centered, thus making harnesses even.

The ends of warp yarn which extend through reed at front of loom are then fastened to leader or apron, which is wound part way around sand roll and around cloth roll. The let-off is connected at the back of loom, which gives tension to the yarn. The harnesses then have to be adjusted to give a good open shed, the lower part of shed just clearing the race plate at both selvages and the upper clearing the shuttle.

In putting in the lease rods, the back harness is raised, the lease rod slid between the two layers of yarn, the loom then turned completely over until the front harness is up and the front lease rod put in. Some mills do not use the lease rods. The loom is then turned to back center which opens the shed, the shuttle passed to the other end of lay well into shuttle box. The point being well into picker, the belt may then be shipped enough to throw shuttle across. This will lay one pick and at each revolution of the crank shaft the harnesses will be reversed, crossing warp yarn over each pick. The lay of the loom on coming to front at each revolution beats this filling into place, forming the fell of the cloth. This operation is continued until a piece of woven cloth has been formed.

After a piece of cloth has been woven, tension adjusted, harness and reed also adjusted, the loom is ready for smash hand or room girl, who will draw in all the broken ends and put the cloth in perfect condition for weaver who now takes charge and is responsible for production.

In training it will become necessary to acquaint the learner with these different motions, the method of putting in warps before the learner is put on work of his own. The proper operations of the loom depend on the proper adjustments of these motions.

The first operation should be to teach the tying of small hard knots. Let learner practice with two strands of yarn, but in operation, a piece of like yarn is tied to broken strand of warp yarn, one hand making all the necessary motions. The strand of yarn to which the piece is to be tied is placed between thumb and first finger of left hand, allowing the end to extend through the thumb and finger; then place thread to be tied under the one being held, forming a cross or x. The long part of thread is then wound around thumb and around short left and back, between the branches of the x, pressing right short end of x over thread inside of loop over thumb; then draw the loop tight. Other weaver's knots are similar, the object being to teach the weaver to make a clean hard knot in quickest time. This will require practice to become efficient.

Drawing ends through harness eyes and reed: When the loom has no warp stop motion it becomes necessary for operator to keep constant watch for broken ends, which after being discovered are repaired by tying on a like piece of yarn, and drawing through har-

nesses and reed. On looms having warp stop motion the looms stop automatically when warp end breaks.

If the end breaks back of lease rods, the thread is passed over the back rod and under front rod, if it is a back harness thread, and under back rod and over front rod if it is a front harness thread. The weaver will split the warp yarn on each side of broken thread with his hand, spreading open with fingers of left hand which also holds thread to be drawn, and finds the empty harness eye. Then he passes reed hook through eye and catches thread held by left hand and draws this thread through eye. Then opening or spreading yarn in front of harnesses and back of reed will indicate open space or dent in reed through which thread should be drawn.

In different weaves there may be two or more threads in each dent of the reed, but in two harness there are two in a dent. By one method, instead of depending on the opening dent the weaver observes the dent has only one end in it, where the others have two, therefore this shows dent through which the thread should be drawn. After experience, the weaver does not have to look for ends in dent on two harness work as there will be two prominent opening dents, the thread running from back harness to the right opening, and the front to the left.

After drawing in end, weaver holds end down on cloth and starts the loom. If shipper handle can not be reached while holding end, the end is passed under several ends at fell of cloth, binding it and the loom is started. After a few picks have been woven, the loose end may be cut off. In starting loom, push lay back so that the crank will be to back center, being sure shuttle is in box. This will give loom momentum before power for picking motion is applied.

Replenishing filling will not require any special training. The shuttle is taken out of loom and replaced with shuttle having full bobbin. Where there are not extra shuttles used, the shuttle is taken with left hand, right hand raising spindle and removing spent bobbin. Then replace it with a full one, and find the end of filling, spindle being pushed down into place; and thread the shuttle with end of filling.

There are different methods of threading shuttles, one method being to bunch yarn at eye and push thread through, but this has been practically abandoned as it is injurious to health. In this shuttle the bunch is pushed in with a wire and drawn out at the side with a wire hook. Other shuttles have arrangements whereby the thread may be passed through a slot by one motion of hand.

Another operation to be learned is *finding the pick*. As the thread of filling breaks or runs out, the loom will probably make one or more revolutions, and in replacing the shuttle with filling it will be necessary to know how to find the pick. The last pick is loosened or tried by hand to see if loose in shed, and if the whole pick is loose, the shuttle may be pushed into the receiving box end. But if the pick is broken the part that is loose is taken out and the shuttle pushed through the shed by hand, placing in a pick of filling.

Should the pick not be found, the loom is turned over until the pick is loose. Then the shuttle is placed in loom at its proper end of cloth.

When turning loom over with no picks inserted, it will be necessary for learner to let back the cloth the number of picks which the loom

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turns over, thus avoiding making thin places. Some looms have arrangements that will not take up cloth unless the shipper handle is fully in notch, but learner should keep this in mind when finding the pick.

Picking out is another operation which requires practice before learner can become proficient. The learner should understand that it is the purpose to produce perfect cloth, and that it becomes necessary to remove bad places in the cloth in order to get best results. These places may be caused by overshots, mispicks, double picks, dirty filling, etc.

First let back the cloth until it is loose, then tear cloth down as far as necessary to remove the bad place, about six inches apart. Then with the picking-out comb in right hand strike the pick toward the reed, which loosens piece of filling, this being taken out by finger and thumb of left hand. This operation is continued until all pieces of filling have been removed. In picking out it is desirable to use as few strokes of comb as possible to decrease liability of weakening and napping yard. After picking as far as necessary the warp beam at the back of loom is turned back until yarn is tight, the lay having been brought forward until crank is front center, the reed against the fell of the cloth. The tension of the cloth is adjusted by turning cloth and sand roll so that when picking is begun there will be no thick or thin places; the pick is then found and the loom started.

Difficulties.

In weaving, the learner should know the causes of bad places in cloth. One of the first things for a weaver to learn is to keep hands clean and dry at all times.

Weaver should make it a practice to walk around looms occasionally when they are all in operation to discover defects, etc., before they are woven into the cloth. He should be careful that reed is not scratched or injured, that harnesses are in good condition as a broken eye will cause breakage of ends. The shuttles also should be handled with care, and kept smooth; weaver should see that temples are in good order. The loom brake should be in adjustment to take hold immediately after belt is shipped from tight to loose pulley.

Filling fork out of order causes thin places, when filling breaks or runs out.

Take-up out of order will cause thick and thin places, uneven and rough cloth, and will affect the tension.

Left-off out of order, sticking or slipping, causes loosening and tightening of cloth, warp yarn breakage, and uneven cloth.

Harnesses should be set right; if too high, will cause overshots, shuttles flying out, and if too low, will chafe on lay, breaking yarn.

Picking motion out of order will cause loom to bang off because of failure of shuttle to reach other side; it will also cause shuttle to fly out and make overshots. The necessary amount of power should be given to shuttle, as too much power or too little power affect the propelling of shuttle.

Cut filling requires the attention of fixer because of shuttle being worn, or improper alignment of reed, entry of shuttle in boxes, etc.

The tension should be adjusted as the warp yarn is used from beam, releasing the weight as the warp decreases in size.

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The learner should watch for mispicks, double picks, misdraws through the reed and harnesses.

A good operative spends part of time walking back of looms when they are all in operation, because he will detect many causes for breaking of yarn, etc. He will notice any large knots coming up which will probably break when passing through harnesses or reed, causing other ends to break. He may also notice waste adhering to yarn, soiled ends, split yarn, hard size, stains, which may be removed before going into cloth, saving the weaver much extra-work. Should these go unremedied it would spoil cloth and the weaver would be declared at fault.

It is necessary that cloth woven be clean, as much of the trouble for which the weave room is held responsible is due to dirty, oily cloth produced by careless handling, dirty hands, or oily aprons or overalls.

In tying knots and drawing in, the hands are apt to be moist, and should be rubbed with starch, whiting, or powder. This will dry the moisture and remove possibility of soiling yarn.

Learner should also watch for broken warp ends, especially where there is no warp stop motion, and as soon as discovered should be tied and drawn in. These breaks not only cause defect in cloth, but the ends are liable to catch around other threads and either break or twist them together, causing floats, which either must be picked out or a piece of the cloth has to be cut off. This is a short end of cloth or remnant.

Starting and stopping.

After the learner has been taught the various motions, the defects in cloth and causes, the tying of knot, drawing in threads, replenishing filling, picking out, finding correct pick, then the starting up and operating should be taught. Teach him to push lay back so the crank will be near back center, to push shuttle well into picker, then all motions being in order, and ends tied in, the shipper handle is pulled smartly into place, the operator being careful that other hand is not between lay and breast beam.

If the lay is not back and shuttle not well into picker, there will not be power enough put into motion of picker to send shuttle across and the loom will stop with a bang, since protection rod dagger engages with frog connected with shipper handle.

In stopping the loom, the shipper handle is pushed out just as shuttle is going from one box to the other, so that it will remain in other box when loom stops. To do this, it will be necessary for loom brake to properly take hold on surface of wheel.

A good plan when stopping loom at night is to have harnesses level, as on some work with one harness up and the other down a mark is apt to be left in the cloth.

In some mills when stopping Saturday, on certain classes of work the shuttle may be removed from the shuttle box; this will keep shuttle in better condition.

Safety.

Weaver should not stand at end of loom more than necessary as shuttles are liable to fly out on account of improper shedding, or a broken end causing a float. However, most looms have a guard on the reed cap which will keep shuttle from rising.

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Teach learner to avoid putting hand between lay and breast beam when it is in operation or between temples and lay; in fact, always to keep hands away from lay while it is in motion. Likewise, to be careful of gears when operating, such as gears on crank shaft and cam shaft. Exercise great care regarding loose garments which may catch in the gears.

Cleaning and oiling.

In many mills where the weaver operates a number of looms, special operatives clean the looms, removing the waste from surfaces and under parts with brush and waste. Some use compressed air to blow waste and lint to the floor, after which it is swept up and carried away. The loom is always stopped when cleaning, and a block of wood is placed in the slide for shipper handle so it can not be started accidentally.

The fast-moving parts are usually oiled by a special operative, but the weaver may have to oil some of these, depending on the local factory organization. Do not use any excess oil because of its liability to spatter. Many mills use grease or heavy lubricant on cams and picking balls.

DRAPER AUTOMATIC LOOM.

On this loom, the picking motion, harness motion, beating up, letting off, taking up and filling stop motions are practically as described in the previous section and learner having mastered the above may apply what he had learned to practically any loom. In addition to these motions there is on this loom a warp stop-motion which causes the loom to stop when a warp thread breaks.

There is also a filling changing device which replenishes the filling automatically while the loom is in operation.

The warp stop motion consists of a girt extending from each side of loom back of the harnesses. Inside and at the bottom of this girt is an oscillating comb that works forward and back when the loom is in operation.

In addition to drawing warp ends through harness eyes and reeds the ends are drawn through heddles, and when the warp is put into the loom these heddles are suspended inside this girt by rods. The tension of the warp yarn holds them up free from these rods, so when an end breaks the heddle drops and rests on this bar or rod, the bottom catching between girt and comb thus stopping the motion of comb and causes connection with shipper handle to disengage the handle and stop the loom.

A learner on this loom should be taught how to readily detect the conditions which cause a loom to stop. For example, the shuttle may be in shuttle box, filling motion in order, then to ascertain if there is an end broken, work the handle on the comb two or three times. This will indicate a heddle down, the weaver usually is able to detect which one. The weaver should loosen this heddle, tie piece of like yarn to warp end, draw through harness and reed, holding the end tight enough to keep heddle clear of comb and then start the loom.

Sometimes a thread of yarn gets loose and heddle hangs low when it will catch between comb and girt, stopping the loom. To remedy this the end is tightened up and loom is started.

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The other motion on the loom which a learner should understand is the automatic filling change where the filling is changed in bobbins while loom is in motion, loom running continuously unless filling breaks. Then the shuttle is taken out and threaded by hand, the pick found, the shuttle put in loom again, and loom started once more.

This automatic device consists of a hopper attached to breast beam of the loom and is composed of three disks, the two inner ones holding the bobbin, the ends passing over the outside disk in notch and fastening to plug on center of outside disk. Best results are obtained when filling is passed over outside disk one notch lower than the continuation of line of bobbin.

There should always be a full bobbin in hopper directly over the shuttle box when lay of loom comes to front center, so that when the bobbin is spent or has but a few yards left and the shuttle box and shuttle are directly under the hopper, the hammer of the hopper strikes the full bobbin, forcing it down into the shuttle and forcing empty one out. This action is operated by filling fork or a feeler adjusted so it will be put into operation when bobbin is empty, or nearly so.

It is necessary that this mechanism always be in adjustment, that the shuttle enter the box properly, that the hammer descend to top of shuttle and that the feeler operate the mechanism when only a few yards are left on bobbin.

Should the filling break when change is made, the loom will stop because of filling stop motion. In such a case the weaver will match the pick, thread the shuttle, and start the loom, but if this happens at every change, it will be because of need of adjustment and the fixer should be called.

There may be two take-up motions on this loom, the positive take up or the regular pick wheel or gear.

The positive take up does not take up the cloth unless the shipper handle is fully in notch, so the weaver does not have to let back the cloth when turning loom over to find the pick, as the fell of the cloth is in same place as when loom was stopped.

With the pick wheel or gear, turning the loom over two or three picks will make a light or thin place which will not be noticed with cloth in the loom, but will be apparent when cloth is held up to light and inspected. Such a defect may be remedied by adjusting the let-back pawl so it will let the pick wheel back one or two teeth, as deemed best by fixer.

As on all other looms weaver must keep hands clean and dry, spend part of time at back of loom, being careful that bobbins are placed in hopper correctly. He should watch tension of cloth, watch for defects in cloth as overshots, mispicks, double picks, cut filling, dirty filling, hard or bunches of size, floats, loops in selvage, long ends when filling changes, uneven cloth, temple burr marks, uneven places after picking out, etc.

Another type of loom similar in principle to the above changes shuttles instead of filling bobbins. The weaver puts full bobbins into the shuttles by hand and places these shuttles in an iron holder attached to breast beam of loom. Eight shuttles usually constitute one set. The ends of filling are tied to plug in shuttle holder used for this purpose.

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The changing is controlled by the action of filling fork or feeler, and when the bobbin is nearly empty, the feeler makes its connection, turning rod, disconnecting shipper handle and stopping loom. Inside of driving pulley is a gear which continues to run and through series of shafts, gears, cams, etc., operates on levers, one raising the front of the shuttle box and pushing shuttle out while the other brings a carrier holding a shuttle with full bobbin on the shuttle box bottom. Then the carrier goes back into place, the front box plate is lowered into position and holds the shuttle. The mechanism continues to operate until the shipper handle is pulled into place automatically and loom starts again.

All these operations are automatic, but weaver must understand them so as to know when loom is stopped for changing shuttles. If weaver were to start working on loom looking for broken warp ends, etc., and loom was changing shuttles, there is liability of accidents. In such a case weaver should observe if gears and shafts of this mechanism are in motion when lay is stopped. All other operations on this loom are the same as on plain looms.

Another make of loom changes shuttles but in a manner differing from the above. The feeler operates a mechanism similar to that of a drop box loom. When the bobbin is nearly empty it raises the regular shuttle box, which affects the shuttle with empty bobbin and a false shuttle box flies into the position which regular box should occupy and carries a shuttle with full bobbin. This false box or carrier remains in this position long enough for shuttle to be picked to opposite end and then drops back, followed by regular shuttle box. The latter is empty and receives the shuttles as it returns from the opposite end.

All other operations are the same as on plain looms, except filling a number of shuttles and putting them in shuttle holder over the shuttle box, or carrier.

FANCY WEAVING.

A weaver on plain looms can readily learn how to operate fancy looms. He will have to learn the operation jacks and adjustment of pattern chain or bars.

The dobby is used where mill makes fancy goods which do not require more than 24 harnesses. This is a head fastened on the end of loom and has 24 jacks to which the top straps of the harnesses are connected while the bottom of the harnesses are attached to the floor with springs.

Under the tilting levers of the dobby is a grooved cylinder geared to turn at each pick, and in grooves of this cylinder are flat bars with upright pegs driven into them, these bars are linked together to form a chain, and as cylinder revolves the upright pegs are presented to tilting levers raising them and allowing jack hooks to drop and connect with knives. The latter slide forward carrying jacks forward and raising harnesses, the number being as many as are required on each pick to form the pattern. Late model dobbies are double index and have two rows of upright pegs to one bar of the pattern chain, giving two picks in the pattern to one bar of pattern chain.

In teaching a weaver on dobbies, the operations on plain looms are taught, the operation of the pattern chain and how to adjust the pattern after the filling breaks, or after picking out.

Teach how to match the pick, to count the number of picks taken out or the number in the pattern, and to turn back the pattern chain to correspond with the number of picks, being careful to see if it is the first or second row of pegs under the tilting levers.

As all patterns repeat after a certain number of picks, this will have to be taken into consideration when adjusting pattern chain, because if pattern repeats at 30 picks and 30 picks are taken out, the pattern chain would remain as it is, and if 26 picks are taken out it should be turned ahead 4 picks instead of turning it back 26.

Weaver should watch for bent pins, short pegs, cylinder that is to one side, etc.

FANCY JACQUARD LOOMS.

Like the doobby this machine can be put over any loom, except that it goes directly over instead of at the end of the loom.

When the goods require more harnesses than the doobby will handle, the jacquard is used. Instead of harness frames, the harness eyes are attached to cords, and drawn through a comport board carried up and attached to hooks of the machine and to slings at the bottom, thus making possible the hitching up of a large number of harnesses or eyes. On the outside of the machine, either side or back according to the tie up (which may be either cross tie or straight tie), there is a pattern card cylinder which presents a perforated card to the needles of the machine on each pick of the loom.

As the needles connect with holes in pattern cards they allow the hooks of the machine to connect with the raising griff carrying them up and raising all harnesses or eyes connected to the hooks, and thus forming the shed.

A single cylinder machine gives one pick to the card, and when the weaver picks out he should count picks taken out and turn back corresponding number of pattern cards.

The same principles apply to this as to the doobby.

KNITTING.

As most knitting mills wishing training will have automatic machines the training will be on such equipment. Since the feed of the machines is simple and only a few strands of yarn are used, training on the operations common to the cotton mills, such as renewing the feed, doffing or removing the finished product, does not require the same amount of emphasis in knitting. If the yarn and machinery are in perfect condition, the only operations are replenishing the yarn occasionally, removing the finished product and keeping the machine oiled and cleaned. Since perfect yarn and perfect running of machinery is almost impossible, it is necessary to teach how the machine operates; to teach the mechanism; how to detect when the mechanism is out of order; to detect imperfect product and to know how to remedy it. Another subject for instruction pertains to starting the fabric or attaching to the needles and to starting the machine, which will operate automatically.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

The subject matter to be taught includes:

- Knowledge of machine.
- Knowledge of defective machinery.
- How to start fabric through machine.
- How to detect imperfect fabric.
- How to remedy defects in imperfect fabric.
- How to clean and oil machine.
- How to remove finished product.

Because of the size and the number of machines operated by one person, the best results probably can be obtained by setting apart a few machines for training and giving complete training on them. In this way a learner can obtain full knowledge of his duties. When machines are segregated, fixers can be taught to take down the machines and assemble them again; to make the adjustments on the different parts such as cams and tensions. They must know how to make the required stitch and repairs. The training for fixers follows the same method as that for other operatives. They are required to actually perform the different operations for adjusting and setting the different cams, etc., until proficient. After the pupil has learned how to make all the adjustments and knows all the drives, the fixing will then be a matter of judgment. If properly trained in the training department, he will have been taught the different causes of trouble that arise in the routine work in the factory, and will know how to make the necessary adjustments and repairs.

While different knitting mills turn out different styles of product, all training in knitting is practically the same in principle and method. The teaching material should be separated and classified to show how long it takes to train on each subject. Although the operations are quite simple, the training considers what operations take the most time, and which are the most difficult. Records should be kept to reveal where the learner has the most difficulty as for example, if it is in starting the fabric, changing the fabric from one machine to the other, or if the difficulty is in learning the action of the mechanical parts, or if it is in learning the causes of and remedy for imperfect work.

Whatever teaching method is used, the learner should understand the machine; how the stock passes through it; how to start the machine and stop it; how to avoid accidents; what the different operations are and how they are performed; why they are performed in a certain manner; what constitutes imperfections in the work, how they are caused and how to remedy or avoid them; how to clean and oil the machines, how to care for the machine. He should also be taught the necessary rules and regulations of the plant.

CIRCULAR RIB MACHINE.

(a) Purpose of machine.

Teach the learner that the rib machine makes rib tops for men's half hose, cuffs for underwear and rib hose for children. The learner should know how the fabric is started and knitted.

(b) Starting and stopping.

The starting of knitting machines is similar in all types, namely by releasing the shifting lever, whereupon the belt is drawn over to the tight pulley by a spring. The learner should see that the work in the machine is ready before shipping the belt. To stop the machine, push the lever, thus shipping belt from tight pulley to the loose one, then catch lever in the notched groove which holds lever until it is released.

(c) Safety.

While the machine parts are all enclosed by guards which cover the gears, etc., dangerous to the operator, the learner should know of these parts and all possible causes of accidents. He should be taught to avoid the handle on the machine. This is on the shaft with the tight and loose pulley, and is used only to run the machine by hand when searching the cause for trouble, such as bent needles. He should avoid coming in contact with needles, or any moving part.

(d) Operations.

Before the learner goes on to a knitting machine, a general explanation of the machine should be given him. Explain that the rib machine has two sets of needles, the cylinder and dial needles, the dial needle making the small inside stitch and the cylinder needle making the large outside stitch.

Stitches and needles are operated by *working cams* which transmit the work of forming the stitch, and *guard cams* which keep the needles from traveling too far after leaving the working cam. In other words, the guard cam works with the working cam to close the cam races and so keep the needle butts in the right path.

The working cams are called stitch cams and propel the needles when they are drawing the stitches. The landing cam projects the needle slightly just after the stitch is drawn. The raising cam projects the needle just before the stitch is drawn and generally contains two rises, one to open the latch and hold it open until the yarn carrier is reached, and the other to clear the latch, where the yarn carrier will keep it from closing before the yarn gets under the hook. A switch cam is one that changes the path of the needle butts and is usually called a guard cam. It controls the travel of the butt especially in high powered machines.

Putting needles in rib machine.—When putting needles in machine, they should be examined to see that they are perfect. To get good work it is necessary to have good needles. Before putting in a needle to replace one that has been taken out, it is best to clean the slot where lint or dirt may have accumulated and this is done by taking a long needle with a hook, but with no latch, and running this needle in the slot, with the hook inside, and clean out the lint. This will save the making of loose wales, or streaks, in the fabric.

In putting in needles, be sure that they are fully in, because if they are not and the machines started, the butt of the needle will be caught by the cam, bending the needle at the butt and perhaps bending and breaking the slot which the needle runs in. A new needle must not bind but must run smoothly although there should be no play in the slot. If the needle sticks, it may be due to varia-

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tions in the needle, to dirt or lint in the slot. It also may be due to slot being closed a little because of a needle previously having been caught in it. Or there may be a burr at the end of the needle which should be removed.

Hook fabric.—After the learner has been made familiar with the needles, how to replace them, how to detect bad needles, or why they are not working as they should, the learner may then be taught how to hook the fabric. It is first necessary to get a piece of fabric the same as that which was on the machine. Cut off the end so as to have smooth edge, then to pass it up through the cylinder. Then take a long needle which is hooked, but with no latch, pass it between the dial and cylinder, catch hold of the fabric and hook it lightly on the cylinder needles just in front of the carrier. After catching a few stitches on the cylinder needles the feed is threaded with the yarn laying so as to catch the cylinder needles; then with long needle catch fabric lightly over cylinder needles, being careful to put the fabric on very lightly.

After catching the fabric over the cylinder needles, the carrier being threaded, the machine is ready to start. In starting the machine, always start by turning the hand wheel slowly, holding the fabric with the other hand until the needles are working free, then pull the fabric through the take-up rollers, which will then permit the use of the two hands. The machine is then turned slowly to see if all the latches are open, stopping each time when opening the latches, and continue until all the latches are open and the machine is running true. (The best place to look for closed latches is just in front of the carrier.)

After the machine is running true, the chain or pattern wheel is turned so as to make the welt first, watching the fabric until it has passed through the rollers. The fabric is then examined carefully to see if the work is clean and the machine also examined to see that there are no bent needles or closed latches.

It is necessary to watch for a run off and to pick the fabric up lightly over the cylinder needles which will eliminate the breaking of needles. With a little practice a boy or girl will learn to pick up a run-off in a few minutes and have the machine running true.

(e) Difficulties, etc.

As the knitting machine is automatic, it is necessary for the learner to know how to remedy the difficulties and defects in the fabric which will lessen the cause for stopping, etc.

Stitches dropped from needles are caused by dial latch closing under yarn carrier. To remedy this, it is necessary to lower the carrier as close as possible to the dial needles without touching them.

Stitches dropped from cylinder needles are caused by the cylinder needles rising too soon after drawing the stitch and not releasing it before the dial withdraws to keep the tension on it. To remedy this it is necessary to grind the landing cam so it will not raise the cylinder needles faster than the dial needles are withdrawn.

Needles loading up are caused by lack of sufficient weight on the take-up which necessitates increasing the weight. It also may be due to the yarn being too heavy for the hooks of the needles to carry through, and needs the use of lighter yarn; or the stitch may be too tight and will have to be loosened.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

The adjustments necessary for the above necessitate the services of the repair man, but the learner should know that if these stitches are dropped quite often, it is because the machine needs adjustment.

(f) Cleaning and oiling.

Cleanliness is necessary to keep the machine in good running condition. It should be wiped from dust and lint at least four times during the day and the last thing at night. The machine should be fanned with a heavy piece of cardboard to keep the lint from being drawn in with the yarn to the needles and clogging the yarn carrier. If this lint clogs the yarn carrier, it causes a run-off, necessitating stopping the machine and picking up the fabric over the cylinder needles again. This lint may also bunch up and run down through the yarn carrier and break a number of needles. The learner should know that keeping the machine clean means no decrease in production but rather will prevent breakage of needles and other causes of stopping.

The learner should be taught to keep the machine well oiled and what parts need oiling, as for example, a few drops in an oil hole, a little around the butts of the cylinder needles, and a little around the dial butts. While a machine must be well oiled, there should not be an excess of oil, as this will cause accumulation of lint. The machines should be oiled once a day.

To keep the machine in best running order requires the services of a good fixer who makes the adjustments when needed, also watches it carefully when in operation.

The fixer must make one adjustment at a time. If the cylinder stitch cam is elevated to shorten the stitch, the dial stitch, which is dependent on it, may break unless the dial stitch cam is brought forward. In bringing out the dial cam, it should not be depressed at the same time, because in doing so it will cause difficulty in finding out which of the two changes must be rectified.

All nuts and screws must be tightened after an adjustment, for if the nuts and screws work loose it will be necessary to make the adjustments over again.

Also after making an adjustment the machine should not be started by power, but by turning it over a few times by the handwheel. This will save breaking of needles and parts of machinery and avoid spoiling work.

One of the important adjustments necessary will be adjusting the yarn carrier. The *heel* of the carrier must come as near as possible to the closing cylinder latches without touching them; the *bottom* of the carrier close to the dial needles without touching; the *inside* of the carrier must come close to the hook of the cylinder needles without touching them. Great care should be taken in setting the carrier, as improper adjustment of it will cause latches to be bent and the breaking of hooks and the dropping of stitches.

All machines must be handled carefully to get good results and an examination made for bad needles. The machine should be taken apart every two weeks or so and cleaned. This will mean taking out the dial and cylinder. The needles must also be taken out, the slots cleaned, the inside of the cylinder head and the cams cleaned. When taking apart a machine remember the order of disassembling and to put the parts back in the reverse order in which they were taken out.

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Corresponding parts are frequently marked with numbers and prick punch marks as an aid in reassembling.

This taking apart and cleaning machine saves needles and keeps machine in first-class condition and results in better work. If training is given in a separate training department, a fixer can study disassembling and assembling to better advantage than on the production floor.

The fixer must become familiar with all the drives, the different parts of the machine and how they operate, and learn how to make all the necessary adjustments and repairs.

A good fixer is one of the most valuable men in the knitting mills, and should be trained with special care.

CIRCULAR LATCH NEEDLE.

(a) Purpose of machine.

The purpose of the hosiery-knitting machine is to make all grades of hosiery, as silk lisle, mercerized, cotton, wool, and plated for men, women, and children.

Fancy hosiery machines make fancy striped hose. The fancy stripes are made by yarn fingers throwing in one color yarn and running in as many courses as necessary. The other yarn is held out of reach until the first color has been knitted the required number of courses; then this yarn, which has been held out of reach by the finger, drops in and the other color comes out and continues until the required width has been knitted.

(b) Starting and stopping.

The starting and stopping of knitting machines are somewhat alike. In starting, the shifting lever is released and the belt is drawn from the loose pulley to the tight pulley by a spring, thus giving motion to tight pulley and machine.

To stop the machine, the lever is pushed over into the notch which holds it, shipping the belt from the tight pulley. The notch holds the lever until it is released to start the machine.

(c) Safety.

The learner should be taught regarding the dangerous places of the machine. Although guards cover the gears and dangerous places there are other parts which the learner should be told to avoid.

The learner should be told of the possible danger of the handle which is on the same shaft with the tight and loose pulley. Accidents may happen here when the operator is looking for trouble, such as bent needles, broken sinkers, etc. This handle is on the right side of the machine and makes the same number of turns as the head or cylinder. Although the danger is slight, the learner should be told of the chance of being struck by the handle when threading machine while it is in motion.

NOTE.—The bobbin stand fastened at the back of the machine has a guide rod extending above the machine about 2½ feet and is used to guide the yarn from the bobbin to the machine. This stand allows the yarn to run more freely from the bobbin. To thread the machine when the yarn breaks at the bobbin, the operator has to step to the side of the machine, reach over and draw the yarn from the bobbin or cone over the guide. If the operator threads the yarn while it is in motion, the handle is apt to injure the operator and her clothes are apt to get caught in the belt.

The machine should be stopped on all occasions for threading, cleaning, oiling, or repairing. Then there will be far less occasion for accidents.

(d) Operations.

General explanation.—In teaching the operation of knitting machines, explain its mechanism, so that the learner will know how it operates and why the operations perform their functions.

The principal parts of the machine should be explained, including the stitch cams, sinkers, and the drum. This drum operates the different parts of the machine and is driven by a chain of links. Some of these links have lugs which raise a lever and push the drum. The drum changes the fingers which carry the different yarn, raises the needles, makes the heel and toe, and when stocking is finished stops the machine. If the machine is making string work or ladies' hose, it can be adjusted to stop when the stocking is finished or to continue and start the making of another.

On the cylinder head are sinkers which are adjusted to a circular ring, each sinker having a slot in which it fits, similar to those in the cylinder in which the needles fit. This sinker ring fits over the cylinder head so there will be a sinker between each needle. The purpose of the sinker is to hold the fabric, keep it from coming above the cylinder needles and to help form the loop.

In the sinker ring is a sinker cam which pulls the sinker back so as to clear when the cylinder stitch cam draws down the needle to form the loop. When the cylinder needles begin to come up after having formed the loop the sinkers begin to come back, and as the needles come up the sinkers, which are between each needle, hold the fabric down. The learner should know how the loop is formed, how the needle is inserted through each one of the original loops, and how the yarn is drawn through these loops to form the next course, which is held on the needles until the operation is repeated.

Transferring rib tops.—The operator must learn the method of transferring rib tops for making half hose. On this rib top is a slack course which is a course of loops in which the stitch or loop is longer or slacker than the rest of the rib top. This course is formed about one-half inch from the end of the top, and is for the purpose of making it easy to transfer these stitches and also acts as a guide for putting the tops on straight.

The transferring is done with a quill ring. This ring contains points which are set vertically in the ring. The ring has the same number of points as there are needles in the cylinder and is made to fit the diameter of the cylinders at the back of the needles. The stitches of the rib tops are put on over these quill-ring points at the slack course and the overplus raveled to the points. After making sure that no stitches are missed or dropped the quill ring is placed over the cylinder at the back of the needles, the needles of the cylinder then come into the points, and the stitches are thus transferred to the needles of the machine.

In transferring the half-hose top to the knitting machine it is necessary that all points of the transfer be directly over the needles, but should not be pressed down on the needles. This transfer is made to fit over each needle with enough allowance so that as the operator gives the top a slight pull the stitches will adjust themselves

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over the needles. Transferring in this way prevents bending needles or needles being caught and heads broken off.

The operator then sees if any stitches have been dropped while making the transfer and hooks them up, one stitch at a time, with a pick-up or hook. This hook is made of a piece of wire bent at the end, its point inserted into the stitch that has been dropped and hooked over the needle.

When rib top is picked on it should be raveled down close to points as any surplus yarn left on needles will cause broken needles or broken places in the fabric when transferred to the machine.

When ready to start machine the stitches should be over the needles and then the carrier is let down. About two inches of yarn, which projects through the carrier guide hole, is laid inside of the cylinder. This will allow the first needles which draw down to make the stitch and catch the yarn. (By allowing only 2 inches to lie inside the cylinder it will leave a short end, and if the operator were to hold the end until the machine had started it would cause a long end and waste of yarn.)

NOTE.—Sometimes the operator will not break off the surplus yarn but lets it remain in the machine where it will get caught in the needles and make loops and sometimes break needles. This will be due to the strain put on the needles caused by the weight of the surplus yarn. The operator must be taught to keep in the loose course when picking on, to have every stitch over quill points and raveled down close to points. This will save needles, make even picking on, saves broken stitches, and increase production.

After the rib top is picked on and the stitches are over the needles the machine may be started by turning the handle a few times to see if all stitches are on and all needles working as they should. When everything has been adjusted the machine may be started by power.

After running a certain length to make the leg the machine changes automatically and makes the heel. To make the heel one-half of the cylinder needles are raised by a lifting cam to the top of the cylinder and held by a wire band and the machine begins to reverse back and forth. Each time the machine reverses the pick-up cam throws up one needle on each side as it goes back and forth, and after throwing up the required number the dropper cam starts and drops them two at a time, while the pick-up cam still continues to pick up one at a time. After the dropper cam has dropped the required number the lifting cam comes up and draws down the remainder of the needles that have been left standing.

The machine then starts revolving and makes the foot, and after knitting the required length; it resumes the oscillating motion and makes the toe, which is knit the same as the heel. After the toe is knitted the machine runs for about 15 courses, preparing the toe for the looping machine, where the toe is closed or finished. The 15 courses on the fabric are made to give the operator a hold to run the fabric on the looping machine when closing the toe.

(e) Difficulties, etc.

A bent needle causes a wavy or loose stitch and should be taken out and straightened, but if bent so much that it can not be straightened it should be replaced.

A broken needle head will result in stitch making no loop and must be replaced. These troubles are not likely to occur when care is used in transferring.

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If the yarn is of good quality, free from large knots and weak places, the machine should knit the hose complete except closing the toe, which is done on a separate machine. After the hose is complete the machine will drop it, throw back the carrier, and level the needles for the next stocking.

After the hose is dropped from the machine, the operator should take it and run her hand inside, examining it carefully to see if there are any holes, dropped stitches, or places made by bad needles. The operator then takes her quill point ring, on which she has picked another top while machine was making the first stocking and transfer it to the cylinder needles, using the same method as on other machine.

The operator should not let the yarn run out, but replenish the bobbin or cone just before it is empty. She should also see that yarn is in proper guide, and watch the carrier guide hole, that no lint accumulates, as lint will not pass through the carrier hole if it has been twisted with the yarn. The operator should watch the yarn carrier when starting a new stocking and remove the lint and keep the bobbin stand clean.

When the yarn breaks or the bobbin runs out, the operator must be taught to tie or twist the yarn properly by taking the end of the yarn from the full cone or bobbin which has been placed on the bobbin stand, twisting between thumb and finger to the end that is about to pass through the machine. This method of twisting is quicker than tying a knot, and also makes a smaller piecing, which is better for the needles. When tying a knot the operator is apt to make it large and leave two long ends which will show in the fabric. Explain that large knots and bunches in the yarn cause much bad work which can not very well be remedied.

In making hosiery it is important that the machine be in adjustment. This will require a good fixer to make the adjustments when the machine is not knitting properly. His work includes adjusting to make the proper stitch and keeping the cams in shape. To produce perfect work, the fixer must also have good yarn and good needles. Needles of an inferior quality will break, make inferior work, and cause waste.

A fixer must take care of the machines, keep them in good working condition, and go over the machine once a week to see that all nuts and screws are tight and that the sinkers and stitch cams are adjusted.

Some of the difficulties which a learner or an operator will experience are listed herewith. The learner should familiarize himself with these so as to know when to call the fixer.

Yarn cutting off when making heel or toe may be caused by the take-up motion being too tight. There may be bad needles, or sinkers may be going in too quickly. Regulate tension so yarn will come through without friction. Remove bad needles and replace with good ones. (Bad needles may be found by counting the stitches on fabric from place where yarn is cut and then back on the needles. The number of stitches and needles should correspond.) When the sinker causes cutting of yarn, they will have to be regulated so the cylinder needles may clear the stitch. This is regulated by adjusting the bumper cam.

Stitches dropped in leg or foot will necessitate the fixer looking over the parts of the machine and making the necessary repairs. The

INSTRUCTION FOR WORKERS IN COTTON MILLS.

stitch cams should be smooth. The carrier should be inspected to see if inside is smooth; or there may be a loose latch needle, which will necessitate removing the needle that dropped the stitch and inspecting to see if latch is loose.

Holes in heel or toe (not cut holes) may be caused by the take-up tension being too light, due to the spring not holding the tension tight enough to keep yarn up. The yarn carrier may be too close to the cylinder needle or the yarn carrier guide may be too rough, causing the yarn to catch in the guide. This will mean taking off the carrier and with a small piece of emery cloth, rolled to fit the guide hole, polishing until smooth.

Loose wales in fabric are usually caused by broken sinkers and the sinkers should be replaced.

Wavy stitch in heel or toe may be caused by one stitch cam being longer than the other and when reversing back and forth it will make one stitch loose and the other one tight. The fixer must take out the stitch cam making the loose stitch or the longest one, grind it down to the size of the other cam, so they will make the same stitch. The stitch cams should be well tightened in their places.

The above are some of the possible defects in the fabric which the learner should understand, even though the fixer will be called on to make the adjustments.

Each machine is provided with an oil bottle used in knitting lisle, silk, and mercerized yarn to help soften the yarn. This gives the yarn a little tension, which straightens out kinks and hard-twisted yarn and causes the yarn to run better because it lubricates it a little.

This oil bottle should be inspected to see that the yarn does not gather too much oil when passing over wick as this will cause a gummy solution or lint to accumulate at the latches and produce stiff latches. The yarn should run very lightly over the wick.

Adequate uniform humidity in the factory is desirable, as atmospheric changes are apt to cause variations in the yarn. Yarn will usually run heavy in the morning when the rooms and machinery are cold and run lighter in the afternoon when the rooms are warmer. Yarn should be kept in a cool damp place, for if kept in a warm room it will become too dry and will not knit well. To knit well yarn should contain a certain amount of moisture and the temperature of the room should be not less than 70°, to get best results.

(f) Cleaning and oiling.

As on all other machines, it is necessary to keep knitting machines free from lint and dust. They should be wiped a few times every day and the last thing at night. The lint should be removed from the surfaces and from between the sinkers, the take-up stands should be cleaned every day as this will prevent lint from being drawn to the needles, causing the latter to break and it also prevents lint from bunching in the carrier guide. This bunching causes the yarn to break.

Keeping the machines clean will result in better work and a saving of needles and yarn.

Machines should be oiled every morning after they have been in operation for about an hour and so are warmed up. With the machines in such condition the oil will have better effect and the machine will run easier.

The operator should oil the running parts and put oil in the holes for this purpose. These are usually indicated by an arrow. The tendency of the operator is to put oil on the machine regardless of the oil holes.

Some of the cleaning and oiling is done by the fixer when he takes the machines apart. About every two weeks, the cylinder head should be taken out, all needles and sinkers taken out and given a thorough cleaning, the needle and sinker slots cleaned by running a fine pointed piece of steel through each slot, removing the lint and hard waste.

After the machine has been taken apart and cleaned, the parts are oiled. While the cylinder is out, the needle slots are greased (instead of oiled). Vaseline or tallow is placed around the needle slots below the butts of the needles with the fingers. This lubricates the needles as well as the slots and the vaseline passes from the needles to the cams and lubricates them also. By using vaseline or tallow, the greasy marks usually caused by the oil will be eliminated. Vaseline or tallow should be placed in slots about twice a week.

(g) General care of machine.

While the care of machine is a duty of the fixer primarily, the learner should help keep it clean, by using care in handling needles, keeping machine well oiled and watching fabric to find parts out of adjustment.

The fixer must inspect the cams and keep them smooth, taking them out and smoothing the surfaces with emery cloth when necessary. When putting the cams back after smoothing, the fixer must put them on tight. He should also go over the machine to see that all nuts and screws are tight.

By teaching the learner just what bad work is and how it is caused, she will be qualified to call the fixer as soon as there is trouble and so she will get better quality and more production. She can save the fixer additional work as well as decrease expense of repairing machines.

LOOPING MACHINE.

After the toe is knitted, the hose will be taken to the looping machine where the toe is closed by sewing or looping. The operation of this machine is very simple, the operator's duties are very few, the most important being to put the stitches on the points. This operation requires nimble fingers and ability to put loops on points rapidly.

In putting the loops over the points, the operator must have each loop of the one course over the loops of the other course. She begins at one end or corner and puts on all the loops and then begins again and puts on the other course. By putting on all the loops and keeping in the slack course, the operator will save cutting stitches when ravelling down.

In teaching a learner on the looping machine she should understand what the machine is supposed to do and how it does it. Rapidity in putting loops on points is the chief requisite in the worker, but this must be done without spoiling work or cutting stitches. Teach accuracy first and after repeating the right method sufficiently, attention can be turned to speeding up.

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An operator on half hose should be able to operate three machines. If she is particularly skillful she can operate four. On three machines of 220 needles, 10 hours a day, an operator transferring own tops should produce about 15 dozen half hose per day.

In teaching the learner, first confine instruction to one machine, emphasis being placed on quality. As soon as she is able to operate one machine according to best methods, another machine may be added, and then a third.

The proper procedure is followed by the operator in keeping three machines in operation.

(a) The operator takes the transfer or quill ring and picks on the rib top and then transfers this to the first machine, adjusting the stitches and starting the machine.

(b) The operator then takes another transfer and picks on the top and transfers it to the second machine, making the necessary adjustment of stitches, etc., and starts the second machine. By this time the knitting on the first machine should be near the heel.

(c) After starting the second machine, the operator goes to the third machine, picks on another top, transfers it to the machine and starts it. The first machine by this time should have finished knitting the stocking. The operator removes the stocking, examines it to see if there are any holes or defects and then picks on another top. She then continues to repeat the operations in this order.

To maintain efficiency, the operator must keep her mind on the work, watch the cones of yarn and watch for run-off. In transferring she should see that the transfer is directly over the needles so that when the transfer is pulled down, it will not bend any needles and when taking the transfer off, it will not pull off any hooks. By keeping in the loose course when picking on tops, it will be much easier to make the transfer. The work will be in better condition and when starting the machine, there will be no stitches dropped and no bent or broken needles.

Getting out of the loose course when picking on will leave ragged ends. When this top is transferred to the machine, there will be two or three loose ends too heavy for the needles to draw down, thus breaking stitches and causing a hole. This necessitates picking this place over again or taking the transfer off and trying another one. The top must be ravelled down clean or the hooks of the needles will pull off when trying to draw the stitch through.

FANCY HOSIERY.

There are many knitting machines making plated hosiery by covering one yarn over the other. In such work the cotton yarn on the inside is covered with the worsted yarn on the outside and knitted so the cotton yarn will not show. To get best results, the worsted yarn should be the same size as the cotton yarn, otherwise the cotton yarn will show. The tension on the cotton yarn should be tight and on the worsted yarn it should be loose.

The operations on the fancy hosiery are practically the same as those on the plain hosiery. However the operator should not mix the colors or the different yarns, and should understand the operations of the fingers in connection with the other operations.

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LATCH NEEDLE UNDERWEAR.

(a) Purpose of machine.

While the purpose of the machine used for this work is to knit underwear for men, women, and children, the principle of the underwear knitting machine is similar to the rib-hosiery machine, except that where the rib-hosiery machine has one or two feeds, the underwear knitting machine has from 6 to 10 feeds. In explaining the purpose to a learner, passage of yarn through the machine should be taught and the functions of the various parts of the machine.

(b) Starting and stopping.

In starting and stopping the underwear knitting machine the learner is merely taught to shift belt from loose pulley to the tight, or vice versa. The machine may be stopped because of broken yarn. In any event the learner should observe what caused it to stop.

(c) Safety.

The machine parts are not exposed, but the cylinder head and handle may be the cause of accident if the operative is ignorant of their operation. She should not put her hand inside of the cylinder or near the cylinder head without first stopping machine. She should also be careful of the handle which revolves when the machine is in motion.

(d) Operations and general explanation.

A knitting machine on underwear usually has from 6 to 10 feeds, which means that it has from 6 to 10 strands of yarn running in, one yarn to each feed and practically doing the same work as 6 to 10 machines of single feed type.

Each section has its own cams and carrier and each is provided with a stop motion. Should the yarn break, when it comes through the yarn guide, the small yarn guide which was held up by the yarn will drop and cause the machine to stop. The machine can then be threaded by piecing both ends of yarn, after which the machine is started again.

Another device which operates the stop motion is a small guide just over the cylinder needles. If a knot or bunch comes through the carrier guide, it will cause this small guide to slide over and allow a pin to drop and work the stop motion, the belt being shipped automatically from the tight pulley to the loose one. The knot or bunch may be removed and the yarn pieced up and machine started.

The take-up rollers take care of all the fabric, revolving while the machine is in operation, pulling downward and holding the fabric down. When the rollers are pulling on the fabric, they are at the highest point and should the machine have a run-off, caused by the yarn breaking around the cylinder, the rollers will drop, as they will have no fabric to grip. Connected to these rollers is a chain which in turn is connected to the shipping rod and when the rollers drop, they cause the chain to release a spring, shipping the belt from the tight pulley to the loose pulley and stopping the machine.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

As the operations of the knitting machine are automatic, it is necessary to teach how to piece up broken yarn; to understand the conditions which will stop the machine, etc. If the yarn were perfect, the machine in perfect condition and working properly, the operator would only have to start the machine, remove the finished product, renew the yarn when it runs out and start the machine when making new fabric or after renewing the yarn, the machine continuing in motion at all times. But as such perfection is practically impossible it is necessary to teach the causes for the machine stopping, how to remedy them, and to keep the machine in operation.

(e) Difficulties, etc.

The machine will stop frequently because of imperfect yarn breaking. Defects in the yarn may be caused by carelessness in making, or if the yarn be in good condition, they may be caused in the winding room when winding from bobbin to cone. Again, bad places in the yarn may be caused by large knots tied by the operators on the winders or by letting bunches pass through the good yarn. A winder should use the weaver's knot in tying the yarn, thereby making a small, hard knot. A square knot is also satisfactory and is tied in the same manner as the weaver's knot, the difference being in manner of crossing the ends. Instead of crossing the end under and holding with the thumb and finger of the left hand as is done with the weaver's knot, the end held by the right hand is crossed over the other end and passed around the thumb of left hand, underneath both ends, once around the end to the right, then this right end is placed through the loop which is over the thumb on left hand and drawn up tight. Both these knots may be tied with the right hand and the left hand holding the ends. The weaver's knot will be found to be a little smaller. If the yarn is uneven and thin in places, these may be eliminated at the winder by giving the yarn more tension or having the strippers close up on the winders. This will cause the yarn to break at the thin places and will necessitate tying knots.

It is imperative that the yarn for knitting mills be of the best quality to get best results, and as many knitting mills buy their yarn it will become necessary for the learner to realize that there is such a thing as bad yarn, and if able to recognize bad yarn during the operations of machine, this will be of great assistance in remedying defects. There are other causes which will make bad work, such as too long a draw on the dial stitch; tight cams; hard pull on take-up; poor needles; worn cams; worn thread guides; guides too close to needles. While these defects and adjustments come under the supervision of the fixer or repair man, the operator should be able to detect them so as to notify the fixer. In this way adjustments can be made immediately, and better quality of work and more production will result.

Operators of the knitting machines have a tendency to try to operate more machines than they are able to keep in constant operation and the operator should realize that it is better to keep six in constant operation than to try to operate eight machines while perhaps keeping only six going. While trying to keep the other two in operation, the quality of work on the six will be neglected.

INSTRUCTION FOR WORKERS IN COTTON MILLS.

The learner should be taught the necessity of keeping the yarn clean. This will mean that the cones or bobbins must be kept off the floor out of the dust and dirt. The yarn should be kept on a covered shelf if possible.

The learner should know how to detect bad needles as this will cause much of the defects in the fabric. She should also know how to detect the defects in the fabric which will be caused by these needles or large knots, etc., and to remedy them before they pass as finished work.

To produce uniform work, the machines must run at uniform speed. This matter is in charge of the fixer who adjusts the belts so that one belt will not be tighter than the other. A belt that is loose will cause the machine to run slower and make a tighter stitch, while the machine with the tight belt will run faster and have a loose stitch.

(f) Cleaning and oiling.

Waste should not be allowed to accumulate around the yarn rack or around the needles. Keep the machine free from waste, dirt, or lint, as this will eliminate much of the bad work which may be caused should this cleaning be neglected.

Care must be used when oiling the machine, for if the oil can drips or too much oil is used around the bedplate or under the cylinder ring, it will drip on the fabric and make spots or stains, or drip on the take-up rollers and the roller will make a spot at each revolution. These spots may be made, even with the so-called stainless oil, so teach the learner to use only a few drops in the places marked for oil and to wipe off all the excess. The cylinder, butts, and sinkers should be oiled, but the operator should be careful not to put any oil on parts of the stop motion as this will cause the accumulation of waste or lint and prevent the stop motion from working freely.

Much cleaning will be avoided if the excess oil is wiped off and machine kept dry. If machines are kept clean and free from lint, they will produce better quality of work, will decrease breakage of needles and lessen the amount of waste, and the operators will be able to get more production. The machines should be wiped at least twice a day.

(g) General care of machine.

To keep the machine in good condition, it will be necessary to have a fixer who understands the knitting machine thoroughly. He should be a willing worker and go over his machines carefully once a week to see that all cams are smooth, that the yarn carrier and guide hole are smooth, to take out bent or broken needles, to remove loose rivet needles, to see that all nuts and screws are tightened, and to see that the machine is well oiled and cleaned.

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