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Preserving Letterpress Copybooks

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In the fall of 2002, several letterpress copybooks from both the Department of Indian and Northern Affairs and the Molson collections required attention, necessitating discussions of appropriate treatment methods and options. The books are large, hold a vast number of thin pages, possess valuable archival information and are suffering from iron gall ink corrosion. The goal of this project was to determine and to carry out an efficient and effective method for stabilizing the damage to facilitate access. The use of solvent activated adhesive-coated tissue was explored as a means of strengthening the paper. Tissue was coated with either Klucel G or a solution of methyl cellulose and wheat starch paste and three methods of re-activating the adhesive and applying the repair tissue were investigated: (1) applying the solvent while the tissue was in-situ; (2) dipping the tissue into the solvent before applying it to the document; and (3) moistening the tissue on blotters before applying it to the document. Concerns focused around the potential migration of the corrosive materials in the ink caused by excess moisture introduced during treatment, and the flexibility and strength of the repairs. After discussing the methods in which letterpress copybooks were created, the manner in which the inks corrode, the condition of the books, treatment options and the results of the trials, it was concluded that repairs with Klucel G-coated tissue followed by proper storage was the most effective method of stabilization for these volumes.

A l'automne 2002, des livres de registre provenant soit du Département des Affaires indiennes et du Nord, soit de la Collection Molson, ont fait l'objet d'examen en vue de leur traitement. Ces grands livres, d'une importance archivistique considérable, comprenaient des feuilles très minces dont le papier souffrait de la corrosion dûe à l'encre ferro-gallique. Le but de ce projet était d'élaborer une méthode efficace et pratique de consolidation des endroits endommagés dans le but de permettre la consultation de ces registres, et d'exécuter le traitement selon la méthode élaborée. Des essais ont été mis en oeuvre en utilisant un renfort de papier mince gommé, dont l'adhésif pouvait être réactivé à l'aide de solvant. Comme adhésif de renfort, on fit des essais avec le Klucel G et aussi avec un mélange de méthyl cellulose et de pâte d'amidon. Trois méthodes d'application furent mises à l'essai : (1) l'application du solvant in situ après que le papier gommé ait été mis en place sur le document; (2) l'humectage du papier gommé en le trempant dans le solvant, suivi de sa pose sur le document; et (3) l'humidification du papier gommé au moyen de buvards humides, suivi de la pose du renfort sur le document. Parmi les points considérés lors du choix de la méthode de traitement, l'un des plus importants était d'éviter le plus possible le risque de la migration des produits corrosifs présents dans l'encre - ce qui augmente avec la quantité d'eau utilisée lors du traitement. D'autres points importants étaient la flexibilité et la force résultante du document après la pose du renfort. Cet article décrit le procédé typographique de ce genre de registre, les mécanismes de corrosion de l'encre ferro-gallique et donne les détails sur les livres traités, c'est-à-dire leur état avant traitement, les options de traitements et les essais précédents le traitement. La meilleure méthode dans le cas de ces livres particuliers s'est avérée la consolidation des endroits endommagés par l'encre corrosive à l'aide de papier renfort mince recouvert de Klucel G. De bons soins et une mise en réserve de haute qualité aideront aussi à préserver ces livres à l'avenir.

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Introduction

> "Archives and Libraries in most parts of the western world have in their collections certain mysterious documents on thin translucent paper unlike anything used for record keeping today. They appear in book form and as single sheets, typed or handwritten, in many different colours of ink, with the text on the back of the sheet. These are letterpress copies, the relics of a document copying process which dominated the reprographic world for over 150 years."[1]

The Library and Archives Canada has letterpress copies in many of its collections, including the volumes of letterpress copybooks in the Molson and Indian and Northern Affairs collections where iron gall ink, along with the unfortunate effects of its corrosive nature, has struck. The physical and chemical deterioration of these books has been intensified by the materials used to create them; copypress paper and iron gall ink, as well as by a recent history of heavy use by researchers. This has created an immediate need for preservation.

Description

The Copypress Process

These volumes of letterpress copybooks are composed of copied letters and records using James Watt's patented copypress process. This process, invented by James Watt and introduced in 1780, employed a thin, translucent paper to gain a reverse impression of an original document written in iron gall ink. Before this, businesses employed copying clerks to laboriously copy records and documents by hand. During this reverse copying method, a damp sheet of unsized tissue was pressed against the written surface of the original. The two pages were sandwiched between oiled sheets and flat boards, pressure was applied through the use of either a screw press or a rolling press, and the copying ink was offset into the copy tissue.

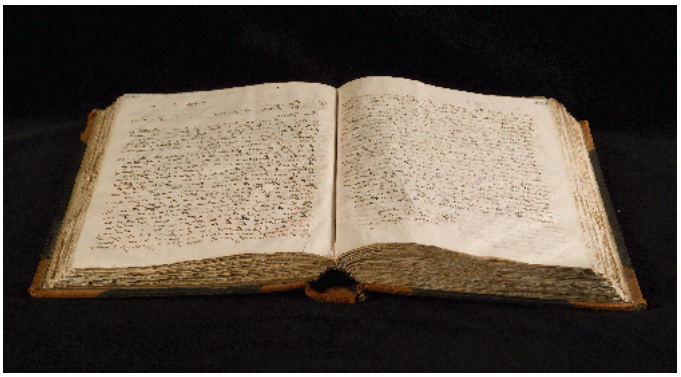

Figure 1. Example of a letterpress copybook.

Unlike the original, with its ink on its front, the copy was printed on the verso; the text is read *through* the translucent tissue itself. The method grew in use and popularity and was used for record keeping well into the 20th century in both the government and private sectors. The copypress process and its development are well described by Rhodes and Streeter in "Before Photocopying."[1]

From Single Sheets to Books

The original means of organizing letterpress copies was to tip the single sheets into existing books of blank pages or scrapbooks. However, by 1815, a method for pressing copies directly onto the pages of a book was patented by William Bell of Edinburgh and the letterpress copybook (**Figure 1**) was created.[1]

> "…the original document is positioned behind the tissue and the tissue is dampened in situ. Sheets of oiled paper are placed on either side to protect the adjacent dry tissue from the damp paper. The book is closed and placed in a screw press for about 30 seconds. After the copies were made in the bound volume, the damp tissues were pressed again between blotters in order to dry and flatten them."[2]

If a press was unavailable, the book itself was used as the 'press.' Pressure was applied to make the copy by standing on the closed book. Owing to the thinness of the tissue (**Figure 2**), and the large number of sheets in one book, the manufacturer provided index pages for quick reference.

Copybooks were bound entirely by hand until the 1880s when machines were employed for sewing and other operations. The binding style was most commonly half leather, with the boards covered in cloth or paper. Bookbinders had standardized a group of binding styles from the onset of letterpress copybook production and the result was a book that was more resilient to frequent handling and to the repeated wetting and drying of the copying process. These structures belong to a genre of books known as stationery bindings, a category which includes all blank books used in record keeping. Letterpress copybooks are often the only evidence of the letters and documents they hold. These volumes were relied upon for maintaining records where the originals were discarded. Now, letterpress copybooks litter [sic] archival holdings in all sectors of the western world.[1]

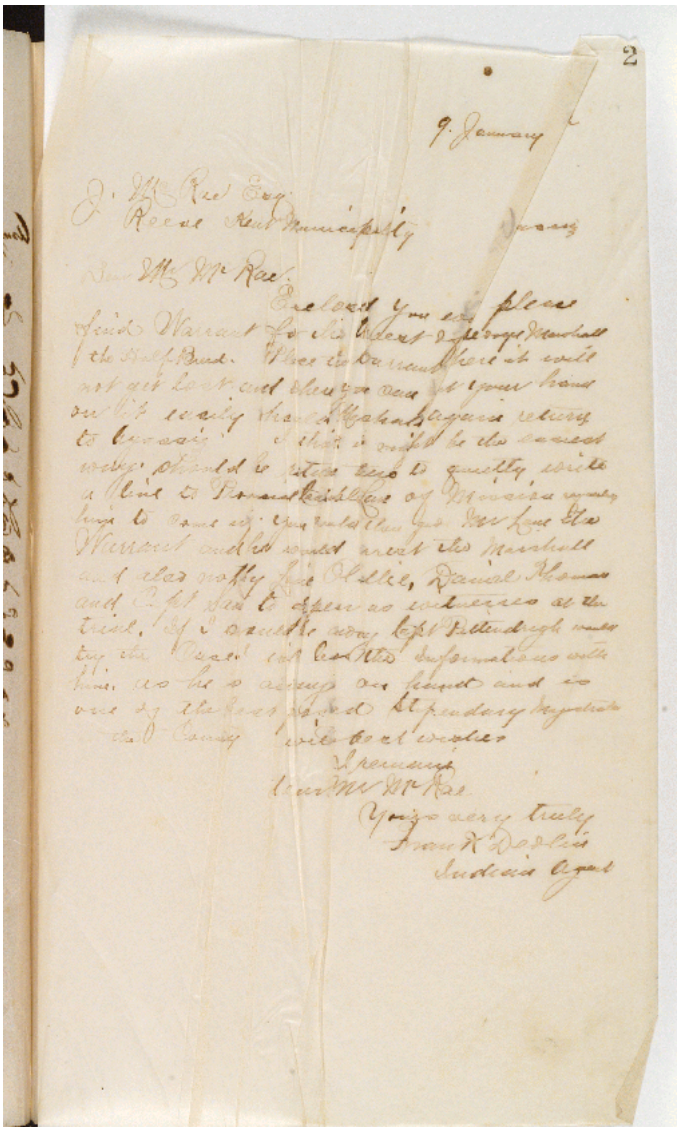

Figure 2. Example of the thin copy tissue against a white background.

Copying Inks

Iron gall ink is formed by the reaction between gallotannic acid from tree galls and iron sulphate. These ingredients are combined in a solution of alcohol or water and held in suspension with gum arabic (**Figure 3**). The resulting ferrous gallotannate compound would oxidize during shelf life and after use, forming a black insoluble precipitate, ferric gallotannate.[3] Variations of this ink exist with different additives and varying proportions of its principal components.

To achieve the best possible transfers, Watt patented an iron gall ink that contained fewer tannins while simultaneously developing tannin impregnated copypress tissue. Fewer tannins in the ink prohibited the complete reaction of the ferrous sulphate on the original, leaving the residual ferrous sulphate to react with tannins in the copypress tissue creating an offset that was as dark and clear as the original.[1]

Figure 3. Ingredients of iron gall ink with a beaker of ink. From left to right: ferrous sulphate (green), galls from an oak tree, white wine in a beaker, and gum Arabic (amber coloured).

Watt's patented recipe endured as the basis for all copying inks, however, new additives were required to satisfy the growing demand for increased productivity. Many of these substances compromised the permanence and stability of the ink. Modifications to the copy ink included the addition of sulphuric or hydrochloric acid to retard the oxidation process, and preservatives such as alcohol to prevent mould growth. The window of opportunity for copying, originally only 24 hours, was lengthened through the addition of sugar, which slowed down the drying of the ink on the original. The introduction of aniline dyes, effective colorants first developed in the 1850s, addressed issues such as increasing the yield of copies from one original, keeping the original legible despite copying, and making the process less costly without affecting the stability of the ink.

The Molson and Indian Affairs Letterpress Copybooks

The Molson Collection is a multiple-media collection that includes 372 volumes of textual records, some of which are letterpress copybooks (**Figure 4**). The collection arrived at the Archives in increments between 1976 and 1992. The records document the personal lives of the first three generations of the Molson family.[4] They also chronicle five generations of Molson business interests in and outside of the Molson brewing and distilling operations, a rich source of material for the study of the socio-economic evolution of Canada. As such, the Molson collection offers one of the most complete and most often used set of documents of Canadian business history.

Parallel in their national historical significance are the departmental records of Indian and Northern Affairs Canada. This collection of letterpress copybooks occupies 130 meters of shelf space. Received by the Archives circa 1964, these valuable archival sources document the lives of First Nations bands when these were first regulated by Indian Affairs agents and policy, and "capture in many instances glimpses of First Nations' culture, traditions and customs" and "furthermore, they are frequently consulted by litigators, historians and departmental researchers involved in the resolution of Comprehensive, Specific and Special Claims against the Crown."[5]

Figure 4. A few volumes of letterpress copybooks from the Molson Collection.

The letterpress copybooks in both collections are made of the materials typical to this type of book, namely very thin translucent paper and specially-designed iron gall ink, and bound in the standard style (**Figure 5**). Each volume varies from the others in its dimensions and in the number of pages. The corners and spines of the bindings are covered in leather with book cloth covered boards. They hold anywhere from a few hundred to fifteen hundred pages each and most have an index. There are few exceptions to this standard in the Molson and Indian Affairs letterpress copybooks.

Figure 5. A letterpress copybook from the Molson collection with typical half leather binding and cloth cover.

Condition

Both the Molson and the Indian and Northern Affairs Collections have a history of improper storage. Previous caretakers have been unable to store the collection appropriately. The Molson textual records, for example, were first stored in the basement of a brewery. To make matters worse, the only initial National Archives storage available for these records was in an offsite building that lacked proper climate control.

The copypress books exhibited moderate to extensive tears, areas of loss to the paper and the "lacing" or break through of the paper, typical of iron gall ink corrosion. The thin copypress paper from the Molson and Indian and Northern Affairs collections is weakened and brittle in response to acidity. The coupling of a heavy transfer of ink onto thin tissue followed by a history of poor storage, has resulted in handling difficulties and a stabilization challenge.

Iron gall ink corrosion of paper is caused by the iron (II) ion catalyzed oxidation and the sulphuric acid hydrolysis of the substrate.[3] The hydrophilic nature of paper allows for migration of these harmful by-products. Although the oxidized ink is not water soluble, the non-reacted iron (II) ions and sulphuric acids are. As humidity is absorbed into the paper, it dissolves the non-reacted iron ions and sulphuric acid, allowing them to move freely through the paper.[6] Appearing first as a greenish fluorescent discolouration, 'haloing' around the ink and extending to the verso of the paper, the iron (II) ions and sulphuric acid continue to break down the cellulose structure as they migrate. This ultimately results in a non-fluorescent brown discolouration, followed by cracks in the ink and through the paper, and finally a loss of material often referred to as lacing.[7]

The Molson and Indian and Northern Affairs copybooks were exhibiting all stages of iron gall ink corrosion. The older volumes show a loss of material and cracked paper at the ink lines throughout the volumes (**Figure 6a and 6b**). The ink in the newer volumes fluoresces, and haloing is evident (**Figure 6c**). None of the volumes are completely without damage or loss of material. Deterioration is not localized to any portion of the pages nor to any specific sections of the text blocks. Storage in uncontrolled environments has caused the paper to become brittle, leaving little support for the corroding ink. Damage was inevitable considering that the volumes were used and mechanical stresses occurred as they were leafed through for microfilming or consultations by researchers.

Treatment

Treatment Rationale

The significance, frequent use and condition of the Molson Collection prompted the National Archives to incorporate it into their annual treatment plan for stabilization (minimal treatment). The Indian and Northern Affairs records had been microfilmed to facilitate frequent use, however, many of the microfilm frames from the letterpress copybooks were illegible. In order to correct

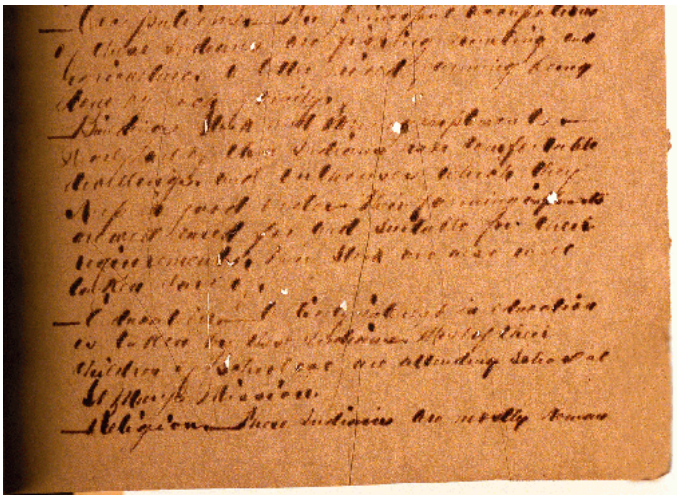

Figure 6a. View of a copypress letter with light shining through the missing ink lines making the paper appear as 'lace'.

Figure 6b. Close up view of lost material within a character against a yellow background.

Figure 6c. An example of the 'haloing' effect of the sulphuric acid as it migrates into the paper appearing as a discoloration around the ink line.

this situation it was decided to stabilize the books to allow for additional microfilming.

When proposing a treatment, consideration was given to the importance of the bindings not only as representations of stationary bindings, but also as part of the press used to create the offsets held inside. Treatment options for these large collections were limited due to the fact that time and resources were not available to mitigate the iron gall ink corrosion. Strengthening the damaged areas, however, can give letterpress copybooks a new life.

To efficiently treat these large, heavy and awkward volumes, a simple yet effective method of minimal treatment was determined. This would involve strengthening the tears and areas of loss with a thin, archival tissue locally applied with a suitable adhesive. Preferably, the application of the repair tissue should avoid the use of water to prevent further migration of the iron (II) ions and sulphuric acid. The thinness and fragility of the copypress paper require a repair that is flexible, to prevent the creation of localized stress points, and it must be easy to apply in order to minimize risks of accidental damage during treatment, and to allow for a more simple method of treatment. These repairs must adhere well to the paper substrate and have enough tensile strength to withstand being manipulated for microfilming and research. Ideally, the repairs should be inconspicuous, reversible and cause no adverse effects to the artefact. The materials and methods described below were evaluated in terms of: whether the repair introduced new risks of damage, strength of the repair, and the ease with which the repair could be removed both by mechanical and chemical means. These factors were tested through gentle manipulation of the copypress tissue as would be anticipated from normal use.

Materials Tested

To accommodate access to this vast source of information the letterpress pages were to be stabilized by supporting the damaged areas with a solvent activated tissue. Two adhesives, Klucel G and a solution of methyl cellulose and wheat starch paste, were evaluated for this project along with three methods of applying the repair tissues. These adhesives were chosen based on their properties and their previous success in similar treatments. All treatment options were compared based on possible adverse affects to the ink and paper, flexibility, strength, and ease of application.

RK-0 machine made Japanese tissue was chosen as the support material for its resemblance in weight, texture and appearance to the copypress paper. It is flexible, inconspicuous and thin, so it does not add bulk to the pages, and does not contain dyes, acids, or other additives. The RK-0 tissue was coated with adhesives that would dry as a film and that can easily be re-activated with solvents for making repairs. Reactivation with solvents avoids the use of excess amounts of water and lessens the possibility of mechanical damage by reducing the steps involved in making the repairs.

(1) Methyl Cellulose and Wheat Starch Paste: "Remoistenable" Tissue

In 1996, Irene Brükle described "Remoistenable" tissue, introduced by Bob Futernick and further developed by Cathy Baker.[8] "Remoistenable" tissue has since been used to stabilize moisture sensitive copper inks at the Walters Art Gallery,[9] which suggested that this method had potential for use on artefacts with iron-based inks.

In this mixture the properties of wheat starch paste and methyl cellulose combine and complement each other. Both have high tensile strength and an adaptable viscosity. They are also readily soluble and have good ageing characteristics. Wheat starch paste is an excellent adhesive but shrinks and becomes brittle when used over a large surface area.[10] Methyl cellulose dries as a very flexible film and resists biological attack as well as acid hydrolysis.[11] Together they make a flexible film with high tensile strength and excellent long term adhesion and ageing characteristics. The wheat starch paste and methyl cellulose can be activated with a small amount of either water or a combination of water and ethanol.

To make the "remoistenable" tissue, reference was made to the Walters Art Gallery handout:[9] 3% Dow A4M methyl cellulose and cooked 1:3 Jin Shofu precipitated wheat starch paste, diluted to the consistency of skim milk, was combined in a 1:1 ratio and brushed onto a strip of 3-millimetre Mylar. RK-0 tissue was laid over the adhesive, and the whole left to dry. The coated tissue was stored on Mylar until use.

(2) Klucel G

Klucel G (hydroxypropylcellulose grade 'G') coated tissues were introduced to the National Archives of Canada by Frank Mowery for the purpose of lining documents. It possesses low viscosity, high tensile strength, photochemical stability, elasticity and a neutral pH. It is hygroscopic and remains soluble in water but can also be dissolved in isopropyl alcohol, ethanol, and acetone. It has been noted that Klucel has a tendency to discolour and break down during thermal ageing testing; however, the lower molecular weight Klucel G has less potential for this behaviour and is considered of intermediate stability.[11] Its exact ageing characteristics are still being investigated. The Klucel G film is re-activated with isopropyl alcohol. This requires the use of proper safety equipment including ventilation and gloves. Although several components of iron gall ink are soluble in alcohols,[12] the isopropyl alcohol evaporates quickly, thereby reducing the risk of sulphuric acid migration.

The Klucel G coated tissue was made in the following manner. A square of RK-0 tissue was placed on a sheet of Plexiglas and covered with a fiberglass screen. A 2% solution of Klucel G in water was brushed over the screen with a Japanese paste brush (**Figure 7**). The screen was then removed and the tissue left to dry. The coated tissue was peeled from the Plexiglas and stored, resting on sheets of Mylar.

Figure 7. Creating the Klucel G coated RK-0 tissue by brushing prepared Klucel G over RK-0 tissue covered with a fibreglass screen.

Application Methods

Three methods of applying the repair tissue to the documents were tested. One letterpress copybook from each of the Molson and Indian and Northern Affairs collections were chosen for these trials. The repair tissues, using both adhesive types, were applied to an inconspicuous area. Polyester release material (Hollytex) and blotting paper were placed underneath the repair areas to provide support and protection. Pieces from each coated tissue were torn by hand, leaving long fibres along the edges, then additionally teased out with the tip of a pin to produce short fibres. The coated tissues were then activated and applied using each of the three methods described below.

1. IN-SITU: Sections of each coated repair tissue were placed on the document and brushed over with a damp artist's brush. The remoistenable tissue required the use of water while the Klucel G coated tissue was reactivated with isopropyl alcohol. This technique is derived from the Walters Art Gallery handout.[9]

2. DIPPING: Using tweezers, sections of the remoistenable tissue were briefly dipped into a small pool of water and applied to the copypress paper. This was repeated for the Klucel G coated tissue, dipping it into a pool of isopropyl alcohol instead. This technique is also derived from the Walters Art Gallery handout.[9]

3. ON BLOTTERS: Sections of each coated repair tissue were placed on blotting paper. The tissues were brushed over with a dampened artist's brush and then applied to the copypress paper. Again, water was used to activate the remoistenable tissue and isopropyl alcohol was used to activate the Klucel G coated tissue.

After application (**Figure 8**), the tissues were smoothed under polyester release material using a bone folder. They were

Figure 8. In situ application of the Klucel G repair tissue. Isopropyl alcohol is applied as the tissue is in position on the document.

then dried between polyester release material and blotting paper under Plexiglas and weights. The adhered repair tissues were tested for strength and flexibility as the pages were turned (as in simple use) and for the ease with which they could be removed. Mechanical removal involved gently using a micro spatula to try and lift the edges of the repair tissues. The remaining tissues were then removed using their respective solvent and the area was dried under weight.

Results

Using the remoistenable tissue either in situ or by dipping introduced excess amounts of water, promoting the risk of migration of iron (II) ions and sulphuric acid. Dipping the tissue caused it to curl, making application difficult. The most efficient way of using the remoistenable tissue was to lay the piece of repair tissue on a blotter for activation.

When using the Klucel G coated tissue, the easiest and most effective method of application was to lay the tissue on the document and then brush it with isopropyl alcohol. Dipping the Klucel G coated tissue in a pool of isopropyl alcohol caused curling, making application difficult. Brushing isopropyl alcohol over the tissue while on a blotter caused it to dry too quickly and resulted in poor adhesion.

Both repair tissues were reversible and had sufficient strength to support the damaged areas. The adhesive film on the remoistenable tissue, however, was thicker than that of the Klucel G film and tended to be stiff on the thin letterpress copybook paper, thereby creating stress. Diluting the methyl cellulose and wheat starch paste mixture might have been an option, however, the main adhesive in this solution, the wheat starch paste, had already been diluted to the consistency of liquid powdered milk. It was felt that further dilution would weaken the adhesive making it unsuitable for the repairs of these frequently handled documents.

The repair tissue that was prepared with the short fibre

lengths and cut out with the tip of a pin, was unobtrusive and preferred over that with long fibres. The latter was torn by hand and the longer fibres were not only more noticeable but could easily be lifted.

Although the remoistenable tissue has been successful for other projects, as described in the literature, it was decided that the Klucel G coated tissue provided a safe and appropriate method of stabilizing the Molson and Indian and Northern Affairs letterpress copybooks. Despite its poorer, but acceptable, ageing properties,[11] Klucel G has two advantages over the wheat starch paste and methyl cellulose mixture. The first advantage is flexibility, an important consideration given that the thin fragile pages of the letterpress copybooks would be handled during microfilming and by researchers. The second advantage of the Klucel G coated paper is the reactivation with alcohol rather than water, reducing or mitigating the movement of free iron (II) ions and sulphuric acid.

Over a period of two months, the authors stabilized the iron gall ink in three volumes of letterpress copybooks belonging to the Molson Collection and one volume belonging to the Indian and Northern Affairs Collection with Klucel G coated RK-0 tissue activated in situ with isopropyl alcohol (**Figure 9**).

Storage and Handling

As moisture is the accelerator in the process of iron gall ink corrosion, the recommended relative humidity for the storage and display of artefacts containing iron gall ink is 40%-45%RH.[1] It has also been noted that a temperature of around 18ºC/68ºF is appropriate.[1] Careful handling remains necessary when lifting or turning the thin brittle pages, especially when closing the book to avoid any further loss of material. One option for making these volumes accessible, without exposing them to further regular manipulations, is to microfilm or to digitize them.

Conclusion

The invention of the copypress process in the late 1700s answered a need for the duplication of important records with reduced effort. The process was an effective tool in an accelerating business world. The simplicity and efficiency of letterpress copying made it common in businesses and government departments, leaving archives and museums with vast sources of information. However, the materials and their degradation have presented a challenge for the caretakers of collections with letterpress copies.

Additives were eventually included to the ink formulations that served to increase productivity. The inks were already imperfect and the long-term deleterious effects of the additives have compounded the resulting problems. Letterpress copybooks may be particularly problematic due to the ink to paper ratio. Such a thin substrate as the copypress tissue is simply not sufficiently substantial to endure the quantity of corrosive products from iron gall ink.

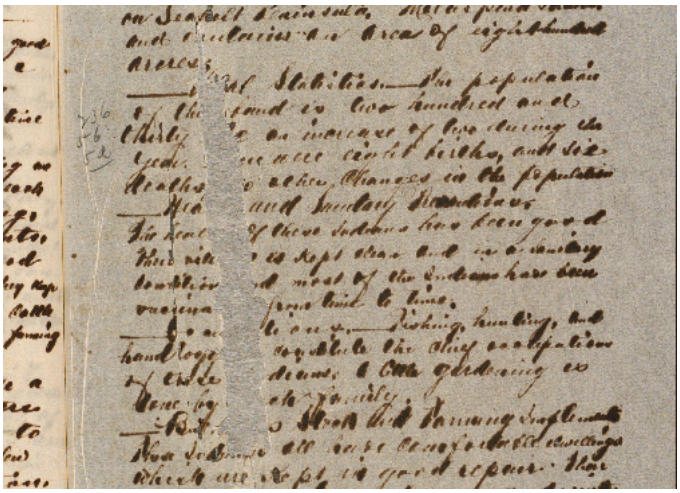

Figure 9. Completed repair of a letterpress copy using Klucel G coated RK-0 tissue applied in situ, against a black background.

After considering the nature of the degradation in the Molson and Indian and Northern Affairs letterpress copybooks and comparing two plausible options, *i.e.* using Klucel G coated tissue and methyl cellulose/wheat starch paste coated tissue, along with three methods of application, an appropriate procedure for stabilizing these volumes was determined. In the end, the Indian Affairs and Molson letterpress copybooks were stabilized using Klucel G coated RK-0 tissue activated in situ on the document with isopropyl alcohol. This option demonstrated the most flexibility, ease of use, and caused the least amount of possible free iron (II) ion and sulphuric acid migration.

Stabilizing letterpress copybooks is an on-going activity aimed at preserving these unique archival artefacts and facilitating access to prominent and highly valued archival material.

Materials

Hollytex (polyester spun-bonded fabric): Carr McLean, 461 Horner Avenue, Toronto, Ontario M8W 4X2, 1-800-268-2123, website: www. carrmclean.ca.

Jin Shofu precipitated wheat starch paste: BookMakers International, 8260 Patuxent Range Rd., Suite C, Jessup, Maryland 2079 USA.

Klucel G (hydroxypropylcellulose): BookMakers International.

Methocel A4M methyl cellulose: Dow Chemical Canada, Inc. 151 Steeles Avenue East, Milton, Ontario L9T 1Y1.

Mylar (polyethylene terephthalate) film: Carr McLean.

RK-0 tissue: Listed as Ultra-light Kozo tissue from Paper Nao, 4-37-28, Hakusan Bankyo-Ku, Tokyo 112-001, Japan (RK-O tissue is also available from Bookmakers).

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